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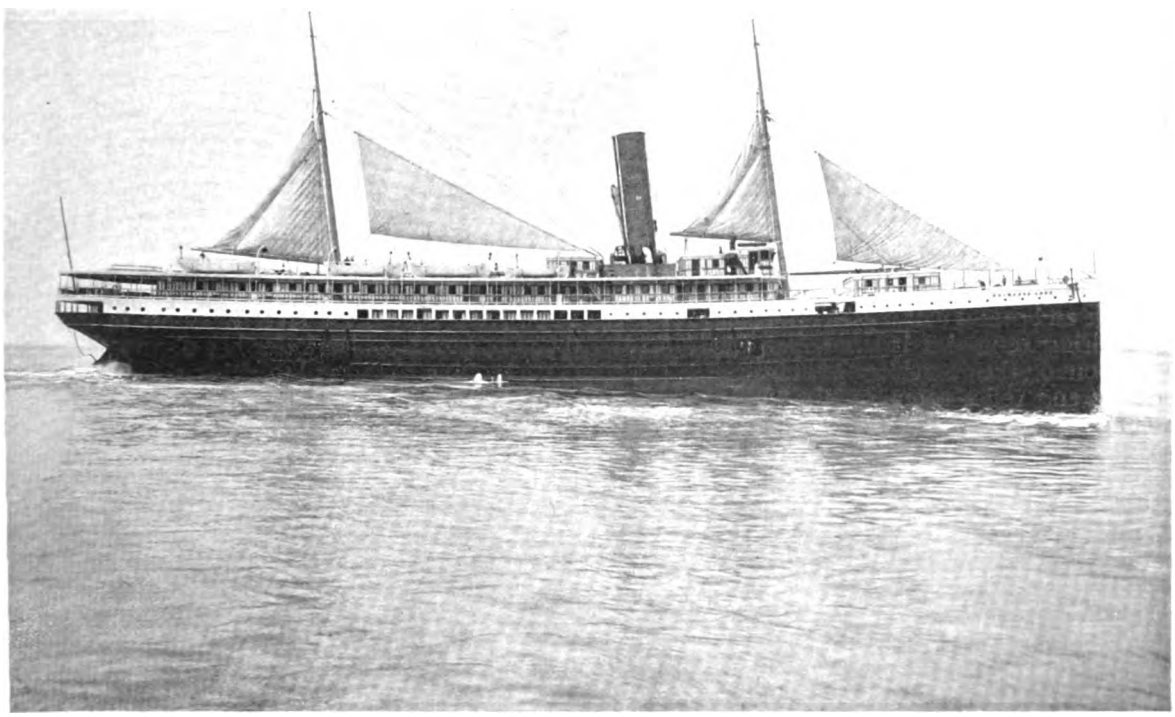
LATEST ADDITION TO THE FLEET OF THE OLD DOMINION STEAMSHIP CO.

Another fine coast liner, the Princess Anne, which has just been added to the fleet of the Old Dominion Steamship Company, is shown in the accompanying illustration. The vessel was launched May 6 last, at the yard of the Delaware River Iron Shipbuilding and Engine Works, Chester, Pa., and started on her first voyage from New York for Norfolk, July 29. She is modeled on the lines of other well-known vessels in this company, and is fitted out in much the same style, with the addition, of course, of many improvements, suggested by Captain Henry A. Bourne, Pres. and William Rowland of the company.

The Princess Anne is 326 ft. 5 in. long, 42 ft. beam and 27 ft. deep molded, and is 3,078 tons gross. She is fitted with two steel masts schooner rigged and has a cargo capacity of 150,000 cu. ft., and on a load draught of 17 ft. is



OLD DOMINION STEAMSHIP CO'S NEW COAST LINER PRINCESS ANNE.

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expected to attain a speed of 16 knots with 3,500 horse power. Her hull is of mild steel, with iron rivets, and she has been constructed throughout according to the highest class of the American Shipmasters' Association, and the U. S. Steamship Owners, Builders' and Underwriters' Association. Captain James A. Smith represented the company during the construction of the vessel which occupied the remarkably short space of eight months. She has five decks, two of which are of steel. The decks are lower and upper 'tween decks, main deck and promenade deck extending right fore and aft, and a hurricane or boat deck carried over the tops of the deck houses and to the rail on the quarter, instead of having awnings over the promenade deck, as on the other boats of the line. There are four water tight cross bulkheads and a water tight shaft alley, giving considerable stiffening to the ship. The saloon is located on the main deck aft of the machinery spaces. This is very handsomely finished in mahogany, with hardwood carpet floor and mirrors conveniently disposed, and all metal work, gilt or silver plated. A beautiful mahogany sideboard occupies the forward end of the room alongside the pantry opening which is situated on the port side of the engine trunk. There is seating accommodation at table for seventy passengers. State rooms extend along the sides of the saloon, which is lighted by skylights and by a central dome, which is overhead the main staircase, leading up to the social hall above on the promenade deck. There are sixty first-class rooms in all on the ship, many of which are fitted with brass beds and they all are provided with the newest toilet accessories, and with Fowler and Wolff steam radiators. The rooms are finished in white, with natural color sycamore woodwork and rich colored carpets. A passageway, with cabins on either side, extends a short distance aft to a sitting room, which is also very tastefully finished in mahogany and furnished with large bookcase and grand piano. Still further aft there is a retiring room for ladies and a finely fitted toilet room on the port side. There is also a large lavatory and toilet room on the starboard side communicating with the sitting room, for men's use. The toilet rooms are fitted with automatic flushing apparatus and rubber tile floors. A promenade space surrounds the deck houses on this deck. The pantry is supplied with a very thorough equipment for keeping foods and dishes warm and has steam apparatus for brewing tea and coffee. Engineer's store room and porters' room are forward of this, alongside the engine trunk, which is near the center of the vessel.

Forward of this casing, conveniently squeezed in between this and the smoke stack, the galley is arranged the full width of the deck house. A French range and steam cooking apparatus are provided, along with the usual complete outfit of culinary utensils for a liner. An ice house and spacious store rooms are also at hand. The galley is ventilated by a shaft carried up close to the funnel housings. Forward of the smoke stack there is a large 'tween deck space for the storage of perishable freight, such as vegetables and fruits. Lidgerwood and Williamson hoisting engines are fitted at the hatches here, and there is also a powerful double elevator, for lowering package freight into the hold. Large cargo ports are conveniently fitted in the sides, with sliding doors so the unsightly outside hinges are avoided. A similar equipment of cargo handling machinery and ports are fitted aft, as will be seen in the longitudinal section published as a supplement to this issue. Forward of the cargo space there is a large room for third-class steerage passengers, fitted with adjustable bunks so the sleeping accommodation can be arranged for any number up to 50 persons. An iron bulkhead here cuts off the forward portion of this deck clear across the ship. On the forward side of this the sleeping cabins for the second-class passengers are situated, the men's and women's communicating by separate staircases, with a sitting room on the promenade deck above. These accommodations are very superior, the privacy of separate cabins being afforded the women passengers. The forecastle is occupied by the crew, bunks for seamen are fitted on the starboard side and for firemen on the port side. Between this and the second-class quarters is the heavy steam windlass and capstan of the American Ship Windlass Co.'s pattern. Ninety fathoms of chain are supplied for each anchor, 1 7-8 in. dia. for the port and 1 3-4 dia. for the starboard.

The hurricane deck does not extend forward of the second cabin deck house, and from the windows of this house on the promenade deck a fine bow view can be had in all directions. Additional state rooms for the first-class passengers are situated on this deck at the back of the intermediate sitting room, with entrances on the sides. The space at the cargo hatches is planked over when the vessel is at sea. Next comes the steel foremast in front of the pilot house, which latter has observation windows looking ahead and to either side. Over the pilot house there is a navigating bridge extending to the sides about 40 ft. above the water. In the pilot house hand wheels are fitted and so connected with a Sickles' steering engine on the deck below that in case of breakdown the engine can be readily disconnected and the vessel steered from the house, by two or four men. Aft in the tiller room there is also a powerful Napier screw gear for use in emergencies. An indicator in the house of the Russell-See patent is connected with the electric side and mast lights, so that should any light go out immediate notice would be given. There is also an electric automatic signal apparatus put in by the Signal and Control Co., which can be set to blow a 7-second blast at intervals of 53 seconds. The after portion of this deck house is occupied by the captain's and executive officers' rooms. The former is very spacious, the full width of the house, and lighted

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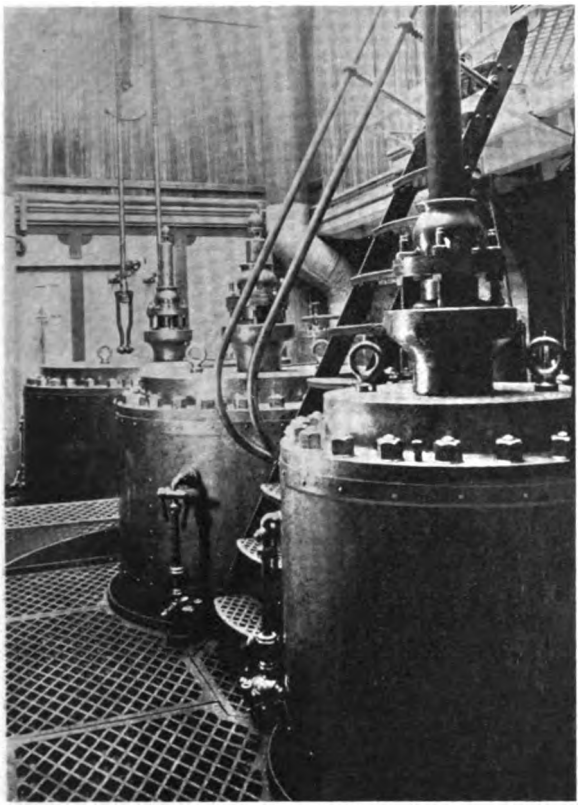
from above as well as the sides. It is fitted as a combined living and chart room, beautifully finished in white and gold with polished mahogany furnishings and cherry and maple floor. The first and second officers' rooms divide the rest of



UPPER GRATING, ENGINE ROOM PRINCESS ANNE.

the house on either side and are finely finished in polished sycamore with hardwood floors. The lower portion of this deck house is occupied forward by the steering engine and between this and the funnel casings by eight outside deck rooms for first-class passengers. These are the most desirable cabins on the ship. The side promenades widen out here into spacious lounging places, where deck chairs can be comfortably placed.

On the promenade deck the large officers' mess hall is sandwiched in between the funnel casings and the engine trunk and overhead there is a spacious smoking room for the first-class passengers. This is very comfortably upholstered in grained leather with polished hazel woodwork. Tables and usual fittings are comfortably placed about. Aft of the engine trunk the social hall and state rooms occupy the deckhouse, light-wells in the center with handrail permitting a view of the main saloon below. The social hall is furnished with upholstered seats and extension table. The state rooms extend to the rear of the deckhouse. On the hurricane or boat deck there is a very complete equipment of patent metallic boats and life rafts.

The machinery equipment of the Princess Anne is very compactly arranged. Experience gained in the operation of the other boats of the line has been put to good use here by George V. Sloat, superintending engineer of the company, not only in the introduction of new apparatus, but also in the convenient arrangement of all. The installment was made at the builders' yard, under the immediate supervision of John B. Sundall, who is now chief engineer of the vessel. The engine which drives the single screw is of the triple-expansion type fitted with Marshall valve gear. This permits of a very compact fore and aft arrangement, as the valve chests are situated on the starting side of the engine. The cylinders are 27 in., 44 1-2 in. and 72 in. by 54 in. stroke. Both cylinders and valve chests are lined with hard cast-iron liners and the main pistons are fitted with tail rods. All the valves are of the piston type, the L. P. cylinder having two. Both the I. P. and L. P. cylinder valves are fitted with assistant cylinders, the I. P. connecting with the H. P. receiver and the L. P. with the condenser. The engine frames are A shaped, the front columns having long openings fitted with doors so that ready inspection of the big ends is afforded when running. The crank shaft is 14 1-2 in. dia. with crank pins 14 1-2 by 16 in. long. The line shaft is also 14 1-2 in. dia. The condenser is rectangular, extending the length of the engine and forming part of the back frames. The air and bilge pumps are worked by levers off the L. P. crosshead, which is over the after crank. Starting gear is fitted on the port side between the I. P. and L. P. columns. The space between the transverse bulkhead and the skin on this side is used for water tanks and bunker shelves. On the starboard side, in a recess which extends to the skin, several auxiliaries are conveniently arranged. There are two powerful feed pumps of the Deane of Holyoke pattern, with brass water ends, a direct connected engine and centrifugal circulating pump, feed-filter, Korting injector and turning engine. On the middle platform on the starboard side there is a large Deane fire-pump and duplex Deane sanitary pump; also an oil filter, to which all drainings are pumped from the crank pits, and also reservoirs for oil. On the upper platform in a recess on the same side, the electric light plant is located. This consists of an Ideal horizontal engine, belted to a General Electric 20 K.W. generator with switchboard overhead. In the passage between the engine and boiler rooms below there is a separator on the main steam pipe connected with a water glass in the engine room. There are two 6-in. bilge ejectors fitted aboard, one in the engine room and one in the forehold.

There are four cylindrical boilers of the regular marine return-tube type. They are single ended 14 ft. 3 in. dia., by 12 ft. 7 in. long, built by the W. & A. Fletcher Co., Hoboken, N. J. The furnace ends are inboard and opposite, two on each

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side of the fire room. Mild steel of 60,000 lbs. tensile strength was used for the boilers. The shells are 1 3-8 in. thick and carry a working pressure of 190 lbs. to the square inch. The combustion chambers are isolated. Tubes are 3 1-4 in. dia. and 9 ft. long, fitted with retarders. A 70 in. American Blower Co.'s fan is fitted on the open stokehold system. There is also an arrangement for induced draught, Bloomsburg jets being fitted at the base of the smoke stack. This is oval 9 ft. by 7 ft. dia. with top 80 ft. above the grates. On a level with the middle platform between the engine and boiler rooms there is a donkey boiler of the Sloat return tube pattern which occupies very little space and gives steam freely. A See's ash ejector is in the fire room, together with an independent Deane ash pump. There is bunker capacity for 180 tons and fresh water storage for 15,000 gallons. The propeller is of cast steel, made by the Pennsylvania Steel Co., of Chester, 16 ft. dia. and 22 ft. pitch and a true screw. It weighs 14,800 lbs. and is a remarkably perfect casting. The Princess Anne will run on the New York-Norfolk route. Her commander is Capt. John Hulphers, who has been with the company for many years.

The method usually employed in testing the speed of a war vessel, before acceptance by the Government, was departed from recently in the case of the gunboat Newport. A run was made over a mile course in each direction at full speed, and the elapsed time for each direction taken. This was halved so as to get the speed of the vessel without the need of taking account of the influences of wind or tide. Further runs were then made at reduced speed and a speed curve was constructed showing the speed of the gunboat at the several different rates of revolutions of the propeller. With this information a time test of four hours was run and the speed ascertained by reference to the curve. The usual method has been to mark a course, with stake boats, of sufficient length to enable a trial run of four hours' duration to be made at full speed. On each stake boat naval officers took note of conditions during the run. These observations acted as a check upon those taken on board the trial vessel. The objections to this system are: the necessity for using a suitable course, the length of time necessary for a trial, and the great expense involved in the use and equipment of the stake boats. The method employed in the Newport trial, which has been tried here before, and is frequently employed abroad, is quick and comparatively inexpensive, though open to some objection. Commodore George Dewey, U. S. N., President Board of Inspection and Survey is of opinion that by the use of this method controversies, depending on the manner of drawing the speed curve, might arise where large pecuniary interests were at stake; while there can be no difference of opinion as to results secured by the usual method.

NAVAL REVIEW AT SPITHEAD IN HONOR OF QUEEN VICTORIA'S JUBILEE.

BY CHIEF ENGINEER JOHN D. FORD, U.S.S. BROOKLYN.

AT noon of June 3 we discharged our pilot off Sandy Hook and stood over for Old England, bearing the flag of Rear Admiral Joseph N. Miller, the special Ambassador appointed to represent the Navy of the U. S. at the Queen's jubilee—the 60th anniversary of her reign. After ten days and ten hours' economical steaming through smooth seas and light breezes we dropped our anchor at about ten o'clock on the morning of June 14 in the Solent-Southampton water off the famous old Netley-Abbey. The next few days were devoted to rubbing off the marks of the sea, burnishing up the ship, fraternizing with the good people of Southampton, and exploring the mysterious old pile that is known as Netley Abbey.

June 19 we steamed down to Portsmouth outer harbor—Spithead—and took our place in the line of guests.

Portsmouth harbor is a splendid sheet of water capable of sheltering the navies of the world, and has sheltered some of the most imposing armaments that have ever been assembled. She has borne upon her bosom the most distinguished naval heroes of English history, and the people of Portsmouth and Gosport have, from the earliest ages, looked upon the many craft, as marvelous in the early days, for their times, as the present great fleet is in these days. Henry VIII, in 1545, sent forth 100 sail. In 1628 the Duke of Buckingham fitted out a great squadron for the relief of the Protestants in France, but an assassin's hand struck him down on the High street and the fleet was dispersed. In 1856, at the end of the Russian war, 254 steam line-of-battle ships, steam frigates, sloops, mortar vessels, floating batteries and troop ships were reviewed here by the Queen. To-day we find the great fleet anchored in three lines of battle, as for the defense of Portsmouth, making a line that is more than twelve miles long, where every vessel is so close to its neighbor that there is only safe distance for swinging to the tide between them. The heaviest and most powerful vessels are in the outside, the cruisers in the middle, and the smaller vessels, torpedo boats and destroyers, are in the inner line, making one of the most imposing sights that it has ever fallen to the lot of man to witness.

Just across the narrow passage between our lines are the Jupiter, Mars, Magnificent, Majestic, Prince George, and Victorious, six of the newest battleships, the oldest of them, the Majestic and Magnificent, having been commissioned in 1895. They are practically alike and displace

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about 15,000 tons with coal, ammunition and stores on board. Each carries four 46-ton wire wound 12-in. guns, firing 850 lb. shot with cordite ammunition; twelve 6-in. rapid-fire guns, which discharge 100 lb. shot, and 38 smaller guns. The 46-ton guns are placed in pairs at each end of the vessel, behind armor shields. They have 9-in. thick plating of Harveyed steel and the deck plating varies from 4 to 2 1-2 in. thick of steel. The ends of the ship are unarmored. Their speed varies from 17 1-2 to 18 1-4 knots. There are four torpedo tubes below the water line and one at the stern above the water line. They are quite high out of water and are intended to be weatherly at sea. They have two masts, which are fitted with tops containing 3-lb. rapid-firing guns and an electric search light. The Hannibal, Cæsar and Illustrious, sister ships, are nearly ready for service. They each have two smoke pipes abreast and very close together.

The Renown is really a smaller Majestic. She is of 13,000 tons displacement and has a speed of 18.7 knots, being the fastest of the British battleships, carries four 20-ton 10-in. and ten 6-in. rapid-fire guns, which are supplied with high-explosive shells, in which cordite is used instead of powder. She also carries 30 small guns—12 and 3 pounders. The 6-in. guns are in casements which are from 4 to 6 in. thick. The side armor is 6 and 8 in. thick of Harveyed steel. She is sheathed with wood and coppered. She has four under-water torpedo tubes. The Renown is a great favorite in the British Navy, and nine similar ships, but of improved design, are being built. She has two smoke pipes abreast and close together.

Further up the line are the Empress of India, Repulse, Resolution and Royal Sovereign. The four are about alike and were finished in 1892. They each have a displacement of 14,000 tons and a speed of 17 knots, and carry four 67-ton 13 1-2 in. guns, in pairs, in pear-shaped turrets that are of 17 in. thickness of steel. The breeches are depressed to load them when they are turned; loaded, and elevated or depressed by hydraulic power. They are armed with 10 6-in. rapid-fire and 30 smaller guns. The armor is compound-wrought iron faced with hard steel. They have seven torpedo tubes. The armor deck lies horizontal about the level of the water line.

The Sans Pareil is a sister ship to the unfortunate Victoria, which was cut down and sunk by the Camperdown in the Mediterranean Sea on June 22, 1893. She has a displacement of 10,500 tons and a speed of 14 knots. She has two 111-ton 16 1-4-in. guns, the largest guns afloat, which are placed side by side in an 18-in. thick turret. She carries a 29-ton 10-in. gun behind a 2-in. steel mask, 12 6-in. guns and 32 smaller guns.

The Benbow, Howe and Collingwood, known as the "Admirals," are of about 10,500 tons displacement and have a speed of about 16 knots. They are not as powerfully armed.

The second-class battleships, in the second line, are the Colossus and Edinburg turret ships, short and squat, like our monitors. They are each of 9,400 tons displacement, with a speed of about 13 knots. The armor for one-third of the length is from 14 to 18 in. thick. There are four 12-in., five 6-in. and 22 small guns besides two torpedo tubes. The Inflexible is of 11,800 tons displacement, with a speed of about 12 knots. She carries four 80-ton 16-in. muzzle-loading guns in turrets. The old Alexandria, which grounded under the Turkish forts while forcing a passage through the Dardanelles, under Admiral Hornby in 1878. Her speed is about 14 knots and she carries four 22-ton 9.2-in. breech-loading and eight 18-ton 10-in. muzzle-loading rifles, besides smaller guns. Her armor is of iron from 2 to 6 in. thick. The two old turret ships, Devastation and Thunderer, complete the line of battleships. They have a displacement of 9,300 tons and a speed of about 12 knots. They carry four 29-ton 10-in. breech-loading guns. The armor is from 6 to 12 inches thick.

Near the center of the middle line are the four armored cruisers. First the Warspite of 8,400 tons displacement, with a speed of 17 knots. She has four 22-ton 9.2-in. guns in four separate turrets, besides ten 6-in. breech-loading and 24 smaller guns. Her armor is from 8 to 10 in. thick and she is sheathed and coppered. The next three, the Aurora, Australia and Galatia, are each of 5,600 tons and have a speed of 18 knots. Their armament consists of two 22-ton and ten 6-in. rapid-firing guns. They have a narrow belt of 10-in. armor on the water line, and a 3-in. thick steel deck.

The two newest first-class cruisers, the Powerful and Terrible, are anchored, near the center of the outer and middle line. They are of 15,000 tons displacement, with a speed of 21 knots. They are 538 ft. long and are powered with water tubular boilers. They have a bunker capacity of 3,000 tons, and are armed with wire-wound guns. One 23-ton, 9.2-in. gun is placed behind shields at each end of the vessel, and there are twelve 6-in. rapid-fire guns in casements behind shields of 6-in. Harveyed steel, sixteen 12-pounders, 23 smaller guns, besides four torpedo tubes. There are 48 separate boilers and the engines develop 25,000 H.P. The steel armor deck, near the water line is 4 inches thick. The Blake and Blenheim are of 5,000 tons and have a speed of about 20 knots. They each have two 23-ton, 9.2-in. guns, ten 6-in. and 25 small guns.

The smaller Blakes are the Royal Arthur, Edgar, Endymion and Theseus. They are of 7,700 tons, 12,000 horse power and 19.5 knots speed. They each carry one 22-ton and twelve 6-pounder guns, and they have an armor deck which varies in thickness from 1 to 5 inches. The largest of the second-class cruisers are the Diana, Dido, Doris, Isis, Juno, Minerva and Venus. They are sister ships, have a displacement of 5,600 tons and a speed of 20 knots. They each

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carry five 6-in., six 4.7-in. rapid-firing, besides 14 smaller guns. The machinery and magazines are protected by a steel deck, varying in thickness from 1 1-2 to 3 inches, and they have a bunker capacity for 1,100 tons of coal.

The Bonaventure, Charybdis, Flora and Hermion are of 4,360 tons, with a speed of 19.5 knots. They are armed with two 6-in. and eight 4.7-in. rapid-fire guns. Still smaller are the Apollo, Eaolus, Andromache, Latona, Brilliant, Melampus, Naiad, Sappho, Sirius, Spartan, Terpschore, Thetis and Tribune, small cruisers of 3,500 tons, with a speed of about 19 knots. They are armed with two 6-in., six 4.7-in. rapid-fire and 13 smaller guns, with four torpedo tubes. The protective deck is from 1 to 2 inches thick. As they only carry 535 tons of coal their usefulness is limited.

The old Mersey of 4,000 tons, with a speed of 17 knots, carrying two 8-in. 14-ton and ten 6-in. rapid-fire guns, and a three-inch thick steel deck, together with the Leander and Pheaton of 4,300 tons and a speed of 17 knots each, carrying ten 6-in. rapid-fire guns, end the cruiser second-class.

The Pelorus of 2,135 tons, a speed of 20 3-4 knots and armed with eight 25-pound rapid-firing guns, leads the van of third-class cruisers. Her coal capacity is limited to 250 tons, which very materially hampers her usefulness as a cruiser. The Barracouta of 1,580 tons and a speed of 16 knots, armed with six 4.7-in. rapid-fire guns, is placed in the inner line, near the entrance to the harbor.

The Medea, Medusa and Magicienne of 3,000 tons and a speed of about 14 knots, have batteries of six 6-in. breech-loading rifles and ten smaller guns, and are placed on the inner line, near the Barracouta.

Twenty torpedo gunboats of the Halcyon class are placed in the inner line of defence, and extend from the Gosport side of the entrance to the inner harbor, away for about three miles. They vary in size from 810 to 1,070 tons and have a sea speed of about 16 knots. They are armed with two 4.7-in. and four 6-pounder rapid-fire guns, besides three torpedo tubes. They have no armor. The Speedy is fitted with Thornycroft water tubular boilers and is the swiftest boat of the group. The 30 Destroyers extend from the torpedo gunboats to the end of the line. Their long, low rakish black hulls, with smoke stacks varying from two to four, give them the appearance of pirates. Their tonnage varies from 240 in the Havock to 300 in the Desperate, and the speed varies from 26 to 30 knots. The horse power from 3,500 to 6,000 or more. The armament consists of one 12-pounder and five 6-pounder rapid-fire guns and two torpedo tubes (the Daring has two 12-pounders and three 6-pounders). Covering the Portsmouth side, entrance to the inner harbor the twenty numbered, but nameless, torpedo boats were grouped. They vary from 127 to 150 feet long and have a speed of about 21 knots. They are armed with five torpedo tubes and two 3-pounder guns. Behind the cover of the fleet rode some 31 old hulks, slow gunboats, tenders, training ships and vessels of no fighting value.

The British war ships were painted black, with white ribbons, with white upper works and yellow smoke pipes and ventilators.

In the outer, or off shore side the foreign vessels were lined up in the order of their arrivals.

The United States was represented by the armored cruiser Brooklyn, bearing the flag of Rear Admiral J. N. Miller. The Brooklyn was fully described in Marine Engineering for July.

France was represented by the armored cruiser Admiral Pothnan, bearing the flag of Rear Admiral C. Marquis de Comthille. The Admiral Pothnan is 370 ft. 6 in. in length, 50 ft. 2 in. beam, of 10,398 ind. horse power and has a speed of 19.2 knots. She has an armament of two 7.4 in., ten 5.5-in., sixteen 1.8-in., eight 1.4-in. guns and five torpedo tubes. She cost $1,920,000 and was built in Havre.

Russia sent the armored cruiser Rossia, bearing the flag of Rear Admiral Nicholas Skrydloff. The Rossia is 480 ft. long, 68 ft. 6 in. beam, with over 12,000 tons displacement, has three propellers, water-tube boilers that are fitted to burn oil or coal, develops 14,500 ind. horse power and has a speed of 20 knots. She carries four 8-in. 192-pounders, sixteen 6-in. rapid-fire, and forty-two smaller guns. She is the largest cruiser in the world, after the Powerful and Terrible, and was built at St. Petersburg.

Italy had the Lepanto, bearing the broad pennant of Vice Admiral Morin. The Lepanto is a barbette ship, 400 ft. 6 in. in length and 74 ft. beam, develops 15,800 ind. horse power and has a speed of 18.38 knots. Her armament consists of four 100-ton (Armstrong), eight 6-in., four 4.7-in. rapid-fire, one 2.2-in., thirty-four 1.4-in. guns, and four torpedo tubes. She cost $5,750,000 and was built at Leghorn.

The Japanese sent the Fuji, Captain Isao Muira. The Fuji is a barbette ship, 374 ft. long, 73 ft. beam, displacing about 12,450 tons, 14,000 ind. horse power and a speed of 18 knots. Her armor varies from 18 to 4 inches of Harveyed steel. She has four 12-in. 850-pounder wire-guns, ten 6-in. rapid-fire and 24 smaller guns and five torpedo tubes. She has two military masts, with tops. She was built on the Thames and was not quite finished as there were about 200 mechanics at work on her during the review.

Germany's representative was the Konig Wilhelm, Rear Admiral H. R. H. Prince Henry of Prussia, K. G. The King Wilhelm is a first-class cruiser, 355 ft. long and 60 ft. beam, 8,350 ind. horse power, with a speed of 14.7 knots. She was an old battle-ship, rebuilt at Hamburg during the past year. She has armor from 6 to 12 ins. thick. Her armament consists of twenty 6-in. and eighteen 20-pounder rapid-fire guns and five torpedo tubes. She cost $2,525,705 and was originally built at Blackwall.

Spain was represented by the armored central-

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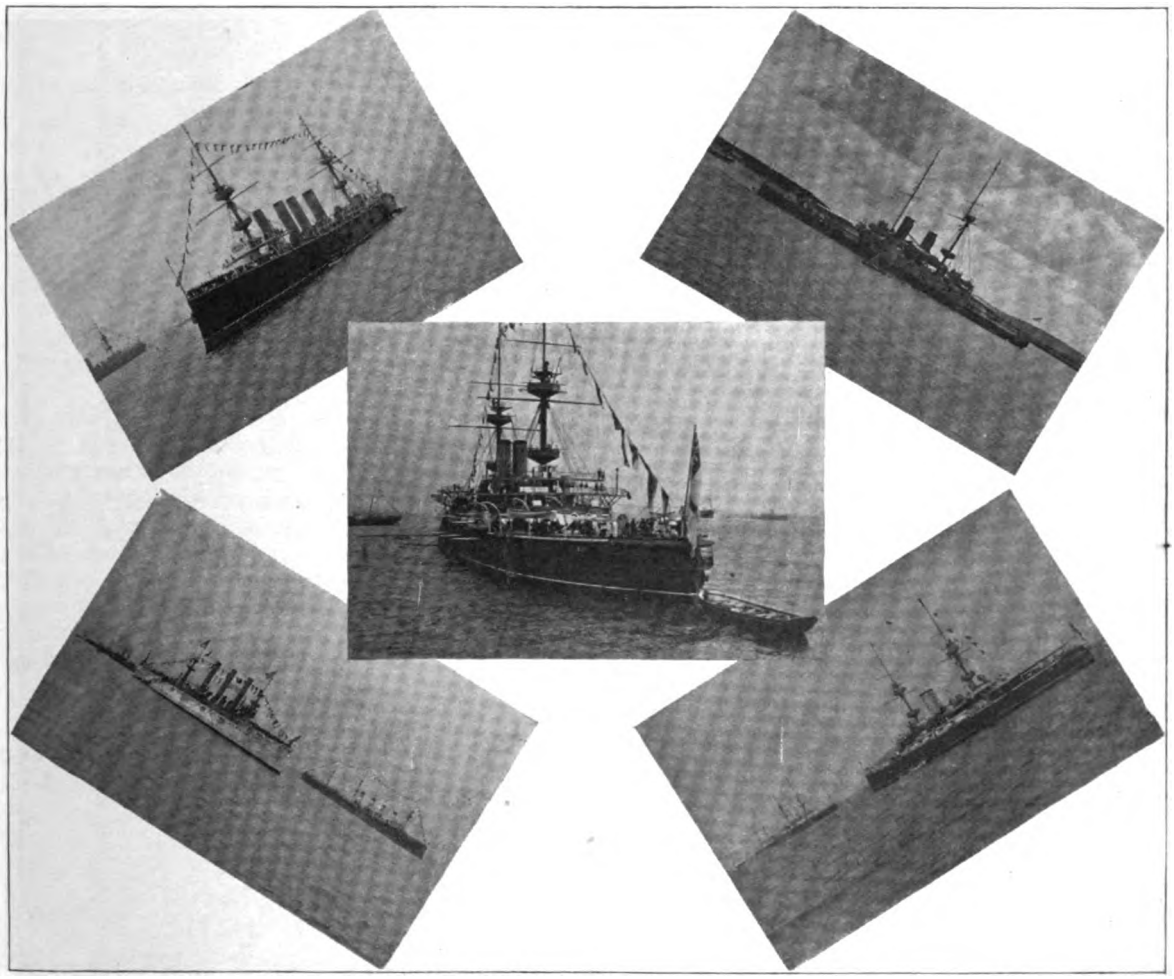
battery ship Vizcaya, Rear Admiral Bermejo y Merelo. The Vizcaya is 340 ft. long, 65 ft. beam, a displacement of 6,890 tons and has a speed of 20 knots. The armor is from 8 to 12 ins. thick. She carries two 11-in., ten 5.5-in., rapid-fire guns and four torpedo tubes. She cost $3,000,000 and was built at Bilbao.

Austria sent the Wein, a battleship of 5,500 tons, bearing the flag of Vice Admiral, The Baron Von Spann. The Wein is 305 ft. long, 55 ft. 9 in. beam, 8,500 ind. horse power and has a speed of 17.6 knots. She is plated with armor 3 to 10 ins. thick. Her armament consists of four 9.4-in., six 5.9-in. rapid-fire, fourteen 47 m. m., rapid-fire guns and four torpedo tubes. She cost $1,695,000 and was built at Trieste.

The Netherlands was represented by the Evertsen, a coast defence turret ship, carrving the flag of Rear Admiral Engelbrecht. The Evertsen is 282 ft. 9 in. long, 47 ft. beam, 4,735 ind. horse power and 16 knots speed. She carries three 8.2-in., two 5.9-in., six 2.9-in. rapid-fire and eight 1.4-in. guns and three torpedo tubes. She was built at Flushing.

Denmark's turret ship Heligoland, bearing the flag of Rear Admiral Koch, has a length of 257 ft. 6 in., beam 59 ft. 2 in., ind. horse power 4,000, and a speed of 12 knots. She carries one 12 in. Krupp, four 10.2-in., five 4.7-in. and four torpedo tubes. She cost $1,375,000 and was built at Copenhagen.

The central battery ship Vasco de Gama, with Captain Vascomelles, represented Portugal. The Vasco de Gama is 200 ft. long and has a beam of 40 ft., is of 3,600 ind. horse power and has a speed of 13 knots. She carries two 10.2 in., 18-ton Krupp, one 5.9-in., two 2.5-in. rapid-fire guns and was built at Blackwall.



H.M.S. TERRIBLE. U.S.S. BROOKLYN. H.I.M.S. ROSSIA. H.M.S. MAGNIFICENT. H.M.S. HOWE. H.M.S. ROYAL SOVEREIGN.

Sweden's little coast defence turret ship Göta, bearing the flag of Rear Admiral Kluctberg, has a length of 258 ft. 6 in. and beam of 48 ft., is of 4,677 ind. horse power and has a speed of 15.9 knots. Her armament consists of two 10-in., four 6-in. and five rapid-fire 6 m. guns, and three torpedo tubes.

The little gunboat Frithjof, Rear Admiral Von Krogh, stood for Norway. The Frithjof is 216 ft. 6 in. long, 35 ft. 10 in. beam and develops 300

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ind. horse power. She carries two 4.7-in., four 2.9-in. rapid-fire, four 1.4-in. guns, and three torpedo tubes (one submerged).

The most important battle ships at the review are the Majestic, Prince George, Victorius, Mars, Jupiter and Magnificent, all of which are identical in displacement, horse power, armor and armament and practically alike in speed.

Near to each other are the Powerful, Terrible, Rossia and the Brooklyn, the four greatest cruisers in the world. The two former carry the heaviest batteries and have about the same speed as the Brooklyn, but the Brooklyn's side armor and protective deck give her greater powers of endurance and the Rossia, being slower than either by more than two knots, excludes her from the race.

At about 3 o'clock in the afternoon of July 26, the royal yacht Victoria and Albert having the Prince of Wales and suite on board, steamed slowly out of Portsmouth harbor, followed by the members of the House of Lords, the Commons (in a large merchant steamer) and the Lords of the Admiralty in their yachts. As soon as the reviewing party were well out of the Ryde, the Royal salute was fired by the vessels, British and foreign, of the great fleet. Superstructures and casemates were manned, and, as the reviewing fleet passed along, the band on each ship played the British National Anthem and the crew gave three cheers for the Prince of Wales.

Moving about and through the lines the little Turbinia, like a whale with a man on his back to steer, did her thirty-five and forty miles an hour with ease. Here, there and everywhere the little craft flew through the water, demonstrating to all the possibilities of the future.

The engineers of the fleet rejoiced that the Queen had seen fit to especially acknowledge her appreciation of and recognition of the services of the Royal Naval Engineers by conferring knighthood upon three Inspectors of Machinery.

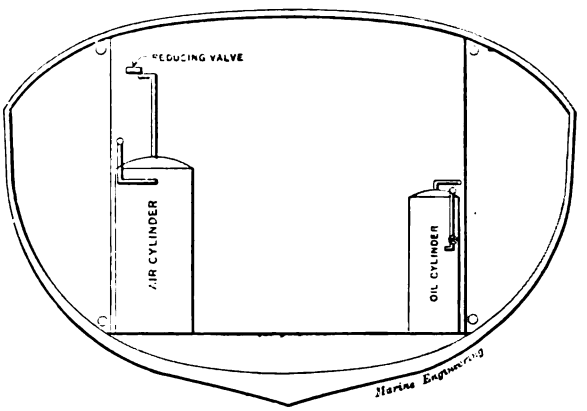
About 6 o'clock in the evening the clouds lowered and soon the rain fell in torrents with sweeping gusts of wind, which continued until about 8 o'clock, when the rain ceased to fall, except in fugitive drops, but the clouds continued black and threatening. At 8:30 o'clock, as if by magic, every vessel of the great fleet flashed forth its illumination and each ship was in a blaze of lights, except the Rossia, which wore its somber colors, but sent forth beautiful fire-works during the whole evening.

Besides the rainbow dressing of electric lights of the Brooklyn, one of her ensigns was fixed aloft and a search-light threw its powerful rays upon it, giving it the appearance of being fixed in the black clouds. The colors were brought out beautifully and the effect was fine. The British flag was treated in the same way from the bow end and the compliment was loudly cheered by our cousins who live on the other side of the great ocean.

RESULTS OF LIQUID FUEL EXPERIMENTS IN THE U. S. NAVY.—II.

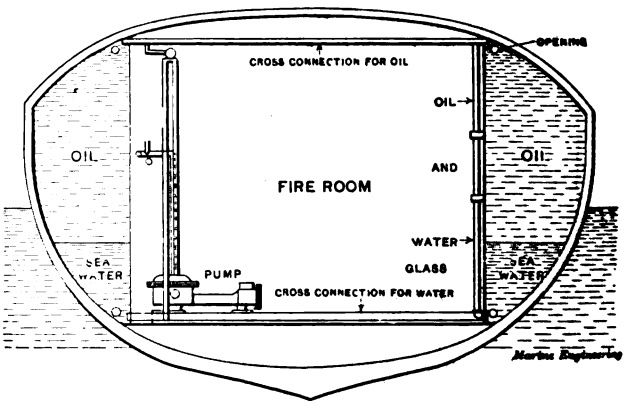
BY J. S. ZERBE.

The torpedo boat used by the Government in its experiments with liquid fuel was designed and built for the use of coal, hence special provisions had to be made for the storage of oil and for supplying the burners. There was no room within the shell of the vessel, and a reservoir was, therefore, placed in each cockpit, fore and aft, the capacity of the two being about fifteen barrels.



SECTION, LOOKING FORWARD, THROUGH 55

The supply pipes were all exposed and laid along the outside of the shell, so that there was no protection during the severe winter, when many of the tests were made. The results showed that this fuel can be used at all seasons with equal success. The oil used is known as "fuel oil," from 34 to 37 gravity, but tests were also made with Lima crude with substantially the same results. It is possible, however, that severe cold would make the crude material sluggish in its movements if used under these same conditions.



SECTION, LOOKING AFT, THROUGH 35

It is desirable that a vessel of this character should keep an even keel and uniform displacement throughout a run, particularly where, as in this case, the fuel forms the ballast. To provide for this a duplex pump is used, one side of which forces sea water into the bottom of the storage

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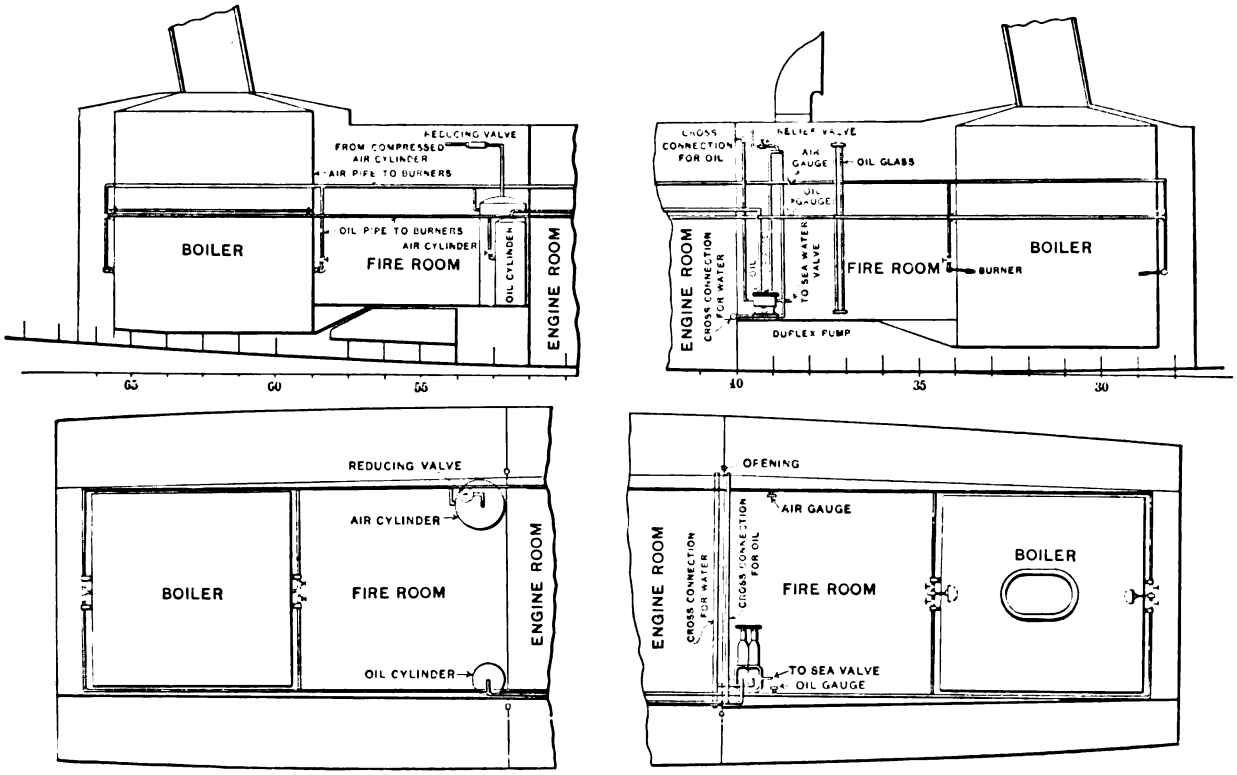

PLANS FOR EQUIPMENT OF 140 FT. TORPEDO BOAT WITH FUEL OIL APPARATUS.

reservoirs for use under the boilers. Pipe connections are made across the tops of the reservoirs and also at the bottom, so that the oil and water is always kept at the same level. As a result there can be no splashing of the liquid fuel, and gases cannot accumulate, because all the spaces within the reservoirs and pipes are at all times filled with either oil or water, and when the

SUMMARY OF TRIALS OF FUEL OIL APPARATUS ON GOVERNMENT TORPEDO BOAT.

Date 1896.	Steam in lbs.		Temperature Fahrenheit.							Barometer.	Pyrometers.		Air Pressure in In. in Fire R.	Oil Consumed in Lbs.	Water in Lbs.			Air Pressure on System in Lbs.	
	Boiler.	Engine.	Air.	Oil.	Engine Room	Fire Room.	Feed.	Dry Bulb.	Wet Bulb.		Starboard.	Port.			Fed to the Boiler.	Vaporized from temperature of feed.	Vaporized from and at 212°	Oil.	Air.
Jan. 30	102.5	100.	41.37	55.	65.	94.	97.	..	..	30.	779	455	.912	887.5	12,929	14.56	16.88	25	15
Feb. 5	100.3	98.5	31.25	35.	60.	83.	94.	..	..	29.5	700	400	.6	635.8	10,965	17.33	20.22	25	7
Means.	101.4	99.2	36.32	45	62.	88.	96	..	..	29.7	739	427	.756	761.6	11,947	15.74	18.45	25	11
Duration of these tests four hours; engines running; 2.98% of moisture in the steam at 100 lbs. pressure; 22 observations.																			
Jan. 31	150.	148.7	46.5	49.5	60.	86.7	96.5	..	..	30.1	851	505	1.65	881.7	13,073	14.82	17.33	30	10
Feb 5	150.	151.	38.6	50.3	55.5	80.2	105.5	..	..	29.1	840	490	1.347	966.6	14,293	14.78	17.14	35	10
Means.	150.	149.8	42.5	49.9	57.7	83.5	101.	..	..	29.6	845	497	1.498	924.1	13,683	14.80	17.24	32.5	10
Duration of first test 3 hours, 28 minutes; second test 4 hours; engines running; 3.33% of moisture in steam at 150 lbs.; 22 observations.																			
Mar. 6	186.	185.3	50 0	50.2	64.7	90.	82.8	..	..	29.8	1252	680	1 862	1088.	16 792	15.43	18.34	30	7
" 28	159.7	198.3	55.1	58.1	65.	88.5	106.7	..	..	30.	out of order	1040	1.592	1213.8	21.778	17.92	20.89	35	7
Means.	192.8	191.8	52.5	54.1	64.8	89.2	94.8	..	..	29.9	..	860	1.727	1150.9	19.285	16.68	19.61	32.5	7
Duration of tests four hours; engine running; 3.87% of moisture in steam at 200 lbs.; 28 observations.																			
June 8	214.2	..	88.	92.9	..	97.4	71.1	78.	73.	30.5	533	543	.895	625.	9.250	14.8	17.79	30	10
" 9	205.4	..	78.5	85.1	..	98.1	70.	73.5	70 3	29.8	528	547	.941	562.5	8.667	15.4	18.12	30	7
Means.	209.7	..	83.2	89.	..	97.7	70.5	71.6	71.6	30.1	530	545	.918	593.7	8.958.5	15.1	17.96	30	8.5
Duration of tests 3 hours, blowing into the atmosphere.																			
June 10	257.	..	66.6	80.2	..	100.8	68.5	66.6	63.6	29.6	648	623	1.817	800.	13.046	16 3	19.76	25	10
" 12	259.	..	76.2	92.8	..	110.5	72.	76.6	61.6	29.7	658	624	1.450	812.5	13.457	16.5	20.01	27.5	12
Means.	258.	..	71.4	86.5	..	105.6	70.2	70.6	62.6	29.7	658	623	1.633	806.2	13.251.5	16.4	19.88	26.2	11
Duration of tests 3 hours; blowing into the atmosphere.																			

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oil is exhausted an equal weight of water, approximately, is within the reservoirs. A relief valve is placed within the water line of the piping between the pump and reservoir, so that the pressure within the reservoir will never exceed two pounds per square inch. The oil side of the pump forces oil from the reservoir to a compression cylinder, which also has a relief valve, and an overflow back to the reservoir, assuring positive regulation of the oil feed.

Compressed air was used at a pressure not exceeding 25 lbs. Under natural draft the pressure was as low as 12 lbs. The oil pressure also varied, not exceeding 30 lbs. at any time.

The accompanying illustrations show the designs for the liquid fuel equipment of the 30-knot torpedo boats, which are now being built. In method of connecting up the oil and air and in furnace equipment they are substantially the same as employed in the torpedo boat tested, but the reservoirs are built in the hulls of the vessels and all the piping is within the shell.

The trials were made with boiler pressures of 100, 150, 200 and 250 lbs. and with natural and forced draft. In making the tests a "Barrus Universal calorimeter" was used, and the design was to make the data full and complete in every detail, extra precautions being taken in all observations. The tabulated statement here given is selected from the entire series of tests, and the average at all pressures is 18.61 lbs. of water evaporated, per lb. of oil, from and at 212 deg. Fah.

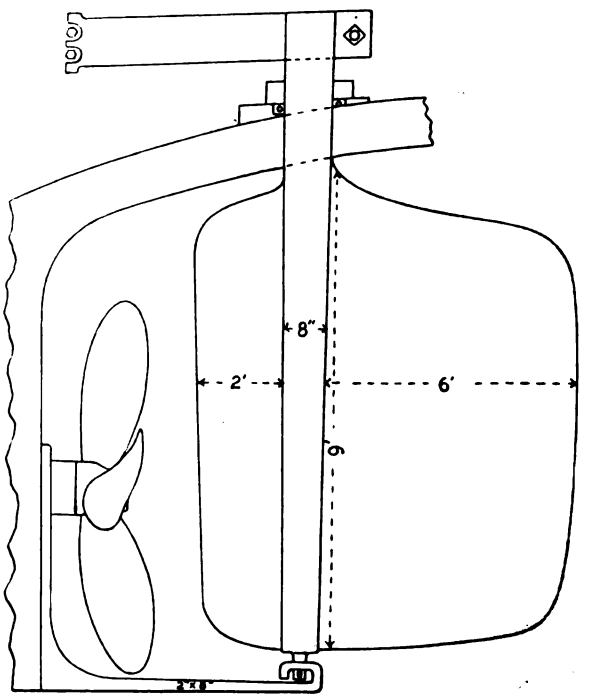
Before making the official tests numerous trials were made to determine the most effective oil and air pressures in the system, and it was found that the best results were produced with air at from 7 to 10 lbs. and oil at from 25 to 30 lbs. The average evaporation with the best Pocahontas coal in the same boiler was about 8 lbs. of water from and at 212 deg. Fah.

A dispatch from Galveston, Texas, states that the North German Lloyd Steamship Co., will inaugurate its service between Galveston and Bremen, August 20. The Hamburg-American Company,, which has established a service between Galveston and Europe, has determined to operate several of its steamships direct between Galveston and Europe without touching New Orleans, which has been custom heretofore.

The William Cramp & Sons Ship and Engine Building Company reports for year ending April 30 last, says the Marine Journal, gross income of $4,500,000, from which was realized a profit on labor and material of $770,000; deducting $340,000 for general expenses, repairs, salaries, interest, taxes, insurance, new machinery, etc., leaves a profit for the year of $430,000, equal to 8.86 per cent on its $4,848,000 capital stock as a result of the year's operations. The debt of the company was reduced $995,000.

LARGE RUDDERS FITTED TO CHICAGO TUGS.

A tugman from the seacoast, on seeing a Chicago tug in dry dock, might be puzzled to make out whether the rudder was an attachment of the tug or whether the tug was merely an adjunct of the rudder. The rudders of the tugs in use in Chicago River and harbor are truly enormous—necessarily so on account of the service required. The narrow, tortuous stream, the innumerable bridges, and the heavy traffic all combine to demand tugs of an extraordinarily high degree of efficiency. And the tugs in use in Chicago are the most efficient in the world. At least, that is what those who ought to know say of them. Seven years ago some one discovered that big rudders made tugs easier to handle. Since then all tugs have been equipped with rudders entirely beyond all rules of proportion laid down by marine architects, and the limit of size has not yet been reached, for each new tug that is built has a still larger ratio of rudder area to submerged area of hull. In detail the practice varies a little, but the principal is everywhere the same. Every builder is convinced that the particular design he follows is the only correct one. The smaller details of measurement vary so much that it is only practicable to speak of general rather than specific types. The general type of Chicago River tug, then, is 80 ft. long over all, 68 ft. long on the load water line, 18 ft. beam and 11.5 ft. deep, draws 9 ft. of water forward and 11 ft. aft. Such a tug would have a rudder 8 ft. long and 10 ft. deep. One-fourth of the blade would be in front of the stock as a counter balance. Sometimes the



SKETCH OF STERN OF CHICAGO RIVER TUG.

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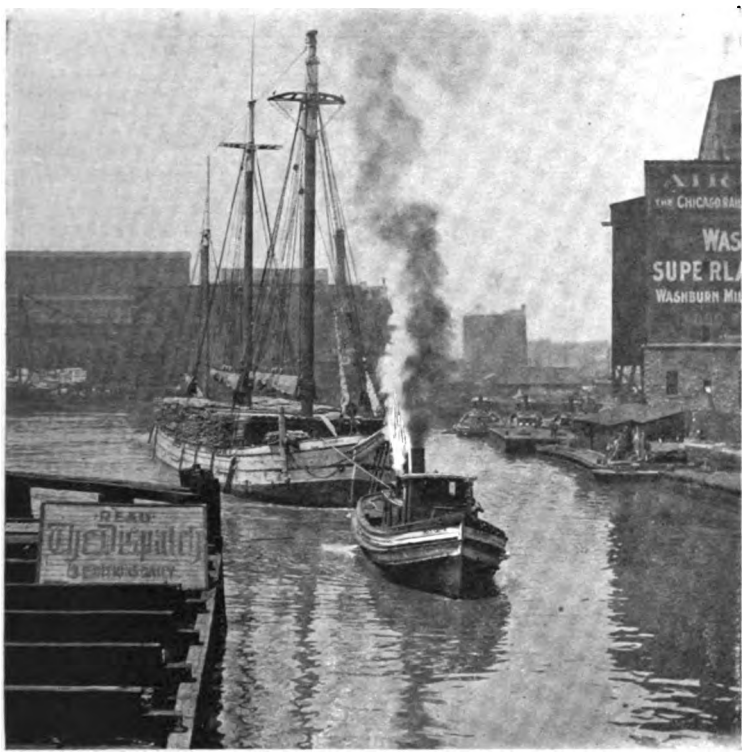
material is iron, but usually it is oak. In the latter case the stock would be oak, with an iron casing, the diameter being 8 in. The thickness on the blade would be 8 in., flaring out to 10 in. at the back, so as to give a slightly concave surface. The usual shape is that of a parallelogram with corners rounded off. Such a rudder when hard over catches almost the full force of the current from the wheel. This gives the tugs great power on a lateral pull and enables them to drag heavily loaded steamers with keels scraping along on the river bottom back and forth across the narrow, devious way they must follow to reach open water. In places where the river is 275 ft. wide one of these tugs will start from the dock on one side, turn around and come up nicely to the dock on the other side. The weight of the rudder is carried on an iron collar clamped to the stock and bearing on an iron block resting on deck. The foot of the stock ends in a pintle setting in a bearing in the iron shoe, which is usually of 2 by 8 in. material. All tugs in Chicago harbor have power steering apparatus, for it would be impossible to manage such enormous rudders in actual service by hand. The time required to put the rudder over from hard over one way to hard over the other way is from seven to nine seconds.



TUG TOWING SCHOONER UP CHICAGO RIVER.

Our London correspondent, in a personal letter referring to the Spithead Naval review, writes thus about the United States Cruiser Brooklyn: "The American was the handsomest of all foreign ships and made a splendid show at night when illuminated."

STEAMSHIP VIBRATIONS WITH RECORDS OF RECENT OBSERVATIONS.*—III.

BY PROF. W. F. DURAND.

In addition to moments tending to rock the engine about a transverse axis, we shall also have moments due to the same forces tending to twist it to and fro about a vertical axis, and reference in the first paper has been made to the forces applied at the slides tending to rock it about a longitudinal axis.

We may now properly inquire as to the relative importance of a balance of resultant force, or of rocking moment. This point was first comprehensively discussed by Herr Otto Schlick[3], who showed that an answer to the question must be sought in the relation of the disturbance to the geometrical characteristics of the natural vibration of the ship. Thus in Fig. 5 is shown the nature of the typical vibration, or vibration of the first order, as referred to in the first paper. If now the engine is located at or near C, where the natural movement is up and down with little or no change of angle, rocking moment is of small relative importance, and the balance of resultant force should receive first attention. In other words, at this point a resultant force will set up strong vibration, while a rocking moment will have but little effect. If, instead, the engine is located at or near the node B, where the amplitude of the motion is small, but where the change of angle is considerable, resultant force is of small relative importance, and the balance of moment should receive first attention. It thus appears that the influence of a resultant force is greater the greater the distance of its point of application from a node, while the influence of a rocking moment is greater the nearer its region of action is to a node. Thus with one end of the engine at B and the other end forward, a resultant force would aid a rocking moment in setting up vibrations. This shows that when the location of the engine is near B or slightly forward, as is usually the case, the L. P. cylinder or heavier moving parts should be aft or near the node, as is customary in usual practice. If on the other hand the engine were aft of the node as is common in tank and lake steamers, the preferable arrangement would be to place the L. P. cylinder

* In the second chapter of this paper, published in the July issue, there are several typographical errors to which attention is here called. On page 4, 9th line from bottom, letters "OQ" should read OR. On page 5, 2d column, 26th line from bottom, commencing "An examination of KBLO," these letters should read KBLD. On page 7, 1st column, 3d line from top, should read $2155 \times 1.75 + 2770 \div 1.75 \div 2767 \times 1.07 = 11580$.

[3] Trans. I. N. A. Lond., Vol. XXXV, p. 350, 1896.

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forward or nearer the node. Since, moreover, the usual location of the engine is slightly forward of B, and since we cannot at present be sure of locating it on the node, it is evident that resultant force and moment should both be counterbalanced as far as possible, and that only by such attention to both can the best result be attained. It is also evident in general, that the rocking moments may be decreased by placing the cylinders with the heavier moving parts between those of lighter parts. Thus with a triple expansion engine the order of the cylinders from forward aft might be HLI, or with a quadruple expansion, HLI_2I_1.

It may also be noted that it is possible to have vibrations of the second order with three nodes and the natural number of vibrations about three times that for the vibrations of the first order as hitherto considered. If the revolutions should rise to this point, serious vibrations of this character might be set up, and as the geometrical distribution is quite different from that of the vibrations of the first order, it might happen that an engine well placed and balanced, relative to vibrations of the first order would give serious vibrations of the second order under the conditions assumed.

We will now state briefly various combinations of cranks or of cranks and counterbalances, for which an approximate balance of rocking moment will exist, as well as those combinations which admit of an approximate balance of both resultant force and moment at the same time.

With a single crank engine the regular counterbalance system may be divided into two equal parts at equal distances forward and aft of the engine, as for example on the crank webs as with the usual crank counterbalances. If the parts are of unequal weight, the product of the weight of each into its distance from the center line should be the same. With two cranks at 90°, each engine may be counterbalanced singly, or the rocking moment relative to either cylinder center line may be eliminated by a single counterbalance system at that end of the engine, with angular direction the same as that of the crank at the opposite end. The longitudinal location of the counterbalance may be such that its characteristic moment multiplied by its distance from the center line of the nearer cylinder will equal the characteristic moment of the moving parts for the other cylinder multiplied by its distance from the same center line. This arrangement will, of course, introduce unbalanced vertical forces, and is therefore of doubtful advisability. With two cranks at 180°, each engine may be single balanced or as above by the introduction of unbalanced vertical forces a balance of rocking moment may be effected by the use of a counterbalance system near either end, of angular location the same as the crank at the other end. The longitudinal location may be such that the product of the characteristic moment of the counterbalance by its distance from the center line of the nearer cylinder shall equal the product of the characteristic moment of the moving parts of the farther cylinder by the distance between the center lines of the cylinders. This arrangement is similar to three cranks of which the two outer are in the same direction and the inner one is opposite. If in such case the weight of the moving parts for the inner crank is equal to the sum of those for the outer cranks, an approximate force balance will exist at the same time. With three cranks at 120°, each engine may be separately balanced, or with equal weights of moving parts the rocking moment may be balanced by the use of a counterbalance system near either end of the engine, of angular location at 90° to the middle crank, and 150° from the nearer of the two end cranks. The system may furthermore be so placed that the product of its characteristic moment by the distance to the center of the engine bed plate will be about 1.7 times the product of the characteristic moment of one set of moving parts by the mean distance between the center lines of the cylinders. This latter arrangement will introduce unbalanced vertical forces, and is therefore not advisable unless there are special reasons for the elimination of the rocking moment. With four cranks at 90° as usually arranged, each engine may be separately balanced, or with equal weights of moving parts the rocking moment may be balanced by the use of a counterbalance system near either end of the engine, of angular location 135° from the crank at that end, and 45° from the crank at the opposite end. The system may furthermore be so placed that the product of its characteristic moment by the distance to the center of the engine bed plate will be about 1.4 times the product of the characteristic moment of one set of engine moving parts by the mean distance between the center lines of the cylinders. This arrangement will also introduce unbalanced vertical forces, and is therefore not advisable unless there are special reasons for the elimination of the rocking moment.

We will now turn to such combinations as admit of an approximate balance of both moment and force. As already noted this is possible with three systems of moving parts with angular locations all in one plane, as with a single engine with two counterbalance systems, or a three crank engine with two outside cranks opposite one inside crank, the weight of the parts for the latter being equal to the sum of those for the former. Where the crank angles are other than 180°, however, a balance of both resultant force and moment requires in general at least four sets of moving parts, of which, of course, none, one, or two may be counterbalance systems. Of these the angular location of any two may be taken at pleasure, and it may then become possible to find locations and amounts for the other two such that an approximate balance of both force and moment shall subsist. If moreover the characteristic moments of one or both the latter are de-

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termined within narrow limits, as would be the case with engine moving parts, it may still be found possible by adjusting angular and longitudinal locations to obtain an approximate balance of both force and moment. This may be seen more clearly by noting that the two systems whose locations and characteristics are fixed, will give a certain resultant force, and with reference to any assumed origin, a certain re-

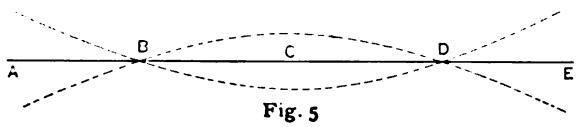

Fig. 5

sultant moment. Suppose now the characteristic moments of the two other systems fixed. Then it may be possible by placing them at a certain angular relation to each other to obtain a resultant force of the necessary amount. If the combination of these two systems is then placed in the proper angular relation to the two given systems, the resultant force will have the necessary direction. Next the second systems may be adjusted longitudinally with reference to the origin of moments, so as to give a vertical rocking moment of the necessary maximum amount. It may then be possible to so change these locations longitudinally as to change the angular location of this maximum without changing its amount. This may be seen to follow from the fact that if one system were located longitudinally at the origin of moments the other could be so placed as to give a moment of the necessary maximum amount, and the angular location of such maximum would be that of the latter system. In this way the angular location of the maximum vertical moment might be brought to either of those for the counterbalance systems, and hence by intermediate locations to intermediate points. This adjustment as a whole may be structurally impracticable, due to the interference of the various systems, and the impracticability of locating them where the conditions would require. Herr Otto Schlick has, however, shown in the paper previously referred to, that with usual proportions of moving parts of four crank engines, several closely approximate adjustments are attainable. In such case the angles between the cranks are

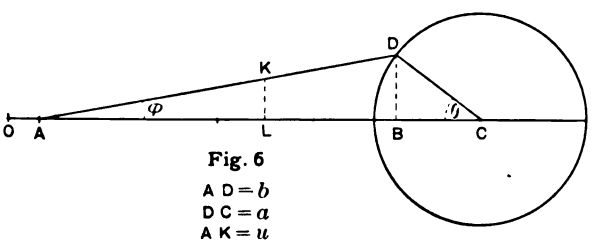

Fig. 6

A D = b
D C = a
A K = u
O A = x

quite irregular, and the turning effort will in consequence be more uneven than in the usual case with equal crank angles. In any case the design of such an irregular arrangement of cranks and moving parts must be considered in connection with the question of general structural arrangement and design.

We have thus considered the various means available for counterbalancing the systems of forces developed by the inertia of the moving parts of an engine, and thus of reducing the final resultant to the smallest practicable limits. We may next state briefly the quantities on which the amounts of such forces depend, in order to show the general relation between the characteristics of the engine and the magnitude of the system of inertia forces. In general, the magnitude of these forces varies as the characteristic moment of the moving parts, and as the square of the angular velocity, or as the square of the revolutions. The forces depend therefore, fundamentally, on the weight of the moving parts, on the length of stroke, and on the revolutions. It is furthermore evident that the change of revolutions is relatively more important than change of weights or of stroke. It must also be remembered that the larger the ratio of connecting rod to crank, the more effective will counterbalance systems become, and the smaller the final residual forces; while the smaller this ratio, the less effective in general a system of counterbalances, and the larger the residual forces. In the example used above for illustration, this ratio is 5 : 1. With ratios of 4 1-2 : 1 or 4 : 1, as are sometimes found, the residual forces given in Fig. 4 would be respectively about 10 per cent and 25 per cent greater than there shown.

Turning now to the ship itself, the conditions generally favorable to the development of the vibrations have been mentioned in the first paper. These will naturally suggest the opposite conditions for which the vibrations will be small. These are as follows: Absence of synchronism or equality of period between the natural period of the ship and the revolutions of the engine. Small power per ton of displacement. Large ratio of depth of ship to length. Large moment of inertia of cross-section of ship relative to the product of displacement by length.

The only modification in the strength of the ship itself which can be made to reduce vibration is in the moment of inertia of the structural cross-section. If the ship is structurally weak or insufficient to withstand the vibratory impulses, members may be introduced giving greater longitudinal strength and rigidity, and thus reducing the extent of the vibrations. In addition to this, the natural period of vibration may possibly be changed somewhat by a considerable change in the distribution of the weights included in the cargo, but usually the resulting modification is small, and but little aid can be expected from this source.

If the whole question of design is under consideration, two points aside from the detailed design of the engine may be made to yield valuable results. If the natural period of vibration of the

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ship can be predicted with reasonable certainty, the revolutions of the engine can presumably be chosen so as to differ considerably from this number, and thus the region of synchronism may be avoided. To this end Herr Otto Schlick has proposed[4] the following formula as giving with reasonable accuracy the natural number of vibrations for ships of the various types indicated:

$$N = \varphi \sqrt{\frac{T}{D\,L^3}}$$

In which:—
N = Natural number of vibrations per minute.
T = Moment of inertia of mid-ship section, areas being measured in square inches and arms in feet.
D = Displacement in tons.
L = Length in feet.
For vessels with very fine lines, such as torpedo boat destroyers..... $\varphi = 136850$.
For large trans-Atlantic steamers with fine lines..... $\varphi = 143500$.
For cargo steamers with full lines..... $\varphi = 127900$.

The second point lies in the location of the engines relative to the location of the nodes and loops of the vibrating ship. The importance of the relation between these locations and the nature of the residual forces due to the moving parts of the engines has been already pointed out. The satisfactory predetermination of these points however, is still a matter of considerable uncertainty. Herr Otto Schlick states[5] that for ships with fine lines he has found the after node at a distance of from .231 L to .253 L forward of the stern, while the forward node was found at a distance of from .310 L to .365 L aft of the bow.

The satisfactory determination of many of these questions, however, cannot be carried on without more data with which to aid the theoretical investigations. While the detailed examination of the problem is beyond reach of purely theoretical means, the approximate theory is not especially complex, and with more extended data, fairly reliable results might be attained. Beyond the reach of all theory, moreover, many points can only be settled by direct and detailed experimental examination, and it is in this field that information relating to the general subject is most needed.

APPENDIX.

In Fig. 6 we have for x, the distance of the upper end of the connecting rod from the origin, the following value:

$$x = a + b - a\cos\theta - b\sqrt{1 - \frac{a^2 \sin^2\theta}{b^2}} \quad \ldots\ldots(1)$$

Let $b \div a = \mu$ and expand the radical by the binomial formula, omitting all beyond the second term. This will give as a closely approximate value:

$$x = a + b - a\cos\theta - \mu a\left(1 - \frac{\sin^2\theta}{2\mu^2}\right) \quad \ldots\ldots (2)$$

whence:—

$$\frac{dx}{dt} = a\left(\sin\theta + \frac{1}{2\mu}\sin 2\theta\right)\frac{d\theta}{dt} \quad \ldots\ldots (3)$$

and,

$$\frac{d^2x}{dt^2} = a\left(\cos\theta + \frac{\cos 2\theta}{\mu}\right)\left(\frac{d\theta}{dt}\right)^2 \quad \ldots\ldots (4)$$

Again, let u be the distance of any element of the connecting rod from the cross-head end. Then for the point K thus located we have the following vertical† and transverse co-ordinates:

$$\left.\begin{array}{ll} \text{Vertical}\ldots\ldots & x + u\left(1 - \frac{\sin^2\theta}{2\mu^2}\right) \\ \text{Transverse}\ldots & \frac{u\sin\theta}{\mu} \end{array}\right\} \quad \ldots\ldots (5)$$

This gives for the corresponding velocities and accelerations the following:

$$\text{Velocities} \left\{\begin{array}{ll} \text{Vertical} & \frac{dx}{dt} - \frac{u}{2\mu^2}\sin 2\theta\left(\frac{d\theta}{dt}\right) \\ \text{Transverse}\ldots & \frac{u\cos\theta}{\mu}\left(\frac{d\theta}{dt}\right) \end{array}\right\} \quad \ldots(6)$$

$$\text{Accelerations} \left\{\begin{array}{ll} \text{Vertical} & \frac{d^2x}{dt^2} - \frac{u}{\mu^2}\cos 2\theta\left(\frac{d\theta}{dt}\right)^2 \\ \text{Transverse}- & \frac{u\sin\theta}{\mu}\left(\frac{d\theta}{dt}\right)^2 \end{array}\right\} \quad (7)$$

Let W_1 denote the weight of the reciprocating parts including piston, piston rod, and cross-head; dW_2 the weight of an element of the connecting rod, W_2 the entire weight of the connecting rod, M_2 its statical moment about the axis of the cross-head pin, and I_2 its moment of inertia about the same axis. Also let F_1 and F_2 denote the total vertical forces due to W_1 and W_2. Then if n denote revolutions per *second* we have:

$$\left(\frac{d\theta}{dt}\right)^2 = 4\pi^2 n^2$$

and from (4) we have:

$$F_1 = 1.226\, n^2\, a\, W_1\left(\cos\theta + \frac{\cos 2\theta}{\mu}\right) \quad \ldots\ldots (8)$$

Also from (7):

$$dF_2 = \frac{dW_2}{g}\frac{d^2x}{dt^2} - u\,dW_2\,\frac{\cos 2\theta}{\mu^2 g}\left(\frac{d\theta}{dt}\right)^2 \quad \ldots(9)$$

Whence,

$$F_2 = 1.226\, n^2\left[aW_2\left(\cos\theta + \frac{\cos 2\theta}{\mu}\right) - M_2\frac{\cos 2\theta}{\mu^2}\right] \quad (10)$$

Similarly for horizontal force H_2 we should have:

$$H_2 = 1.226\,\frac{n^2 M_2}{\mu}\sin\theta \quad \ldots\ldots (11)$$

It is readily seen that for any given position of the rod defined by the angles θ and ϕ, the moment of the horizontal forces about the cross-head pin is:—

$$\text{Moment} = 1.226\, n^2 \frac{I_2}{\mu}\sin\theta\cos\Phi$$

[4] Vol. Trans. I. N. A. Lond., XXXV, p. 350. 1894.
[5] Vol. Trans. I. N. A. Lond., XXXVI, p. 287. 1895.

† The term *vertical* is used with reference to a vertical engine and not with reference to Fig. 6.

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The horizontal force H_3 on the crank pin due to the connecting rod will equal this moment $\div b \cos \varphi$.

Hence we have:—

$$H_3 = \frac{1.226\ n^2\ I_2}{a\ \mu^2} \sin \theta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

or

$$\frac{H_1}{H_2} = \frac{I_1}{\mu\ a M_2} = \frac{I_2}{b\ M_2}$$

The horizontal force on the cross-head is, of course, the remaining part of H_2.

If M_3 denotes the moment of the crank about the shaft center, then the vertical and horizontal forces due to this member are as follows:—

$$\left.\begin{array}{l}\text{Vertical Force} = 1.226\ n^2\ M_3 \cos \theta \\ \text{Horizontal ``} = 1.226\ n^2\ M_3 \sin \theta\end{array}\right\} \quad \ldots\ldots (13)$$

NOTE.

In regard to the actual extent of the vibrations on the S. S. Maine, the records of which were reproduced in the June issue, it may be well to note that the instrument magnifies the movement somewhat. The actual excursion for vibration No. 1 was from 5-16 to 3-8 in. The others are, of course, in like proportion. The instrument with which these vibration records were taken was constructed specially for observations of this character from designs by Prof. Milne, of the Imperial University of Tokio. It registers simultaneously the vertical component of the motion, and a horizontal component which may be made either transverse, longitudinal, or oblique, according to the way in which the instrument is placed.

Admission of Engineers to the Revenue Cutter Service.

While existing laws prevent young men, who are graduates of technical institutions, from obtaining commissions in the regular Navy, the Engineer Corps of the Revenue Cutter Service presents a field for marine engineers who are desirous of entering the Government service. The Treasury Department has recently issued a circular, which is here reproduced, setting forth the requirements for admission to this service. This will be of much interest to those who contemplate following the profession of marine engineering. The examinations are strictly competitive, no political influence being necessary. Any young man who fulfills the requirements may be designated to appear before the examining board. The salary of a Second Assistant Engineer is $1,200 per annum, that of a First Assistant Engineer $1,500, and of a Chief Engineer $1,800. In all three grades the allowance for rations is the same as that for officers of the Navy, thirty cents a day. On detached service where no public quarters are provided, an allowance is also made for commutation of quarters. These positions are for life, subject only to dismissal for incompetency or bad conduct. There are thirty-six vessels of the Revenue Cutter Service, stationed at the various seaports of the country, from Maine to Alaska. The usual term of duty on a vessel is three years; at the expiration of that time the officer is detached and ordered to another vessel. There are at present three vacancies in the list of Second Assistant Engineers, and an examination will be held to fill the same some time during the month of August.

GENERAL ORDER No. 32.

Division of Revenue Cutter Service.

Treasury Department,
Office of the Secretary,
Washington, D. C., June 11, 1897.

The following rules and regulations amendatory to paragraph 8, Regulations of the Revenue Cutter Service, governing the admission of candidates to the grade of Second Assistant Engineer in said Service, are hereby published for the information and guidance of all concerned:

1. No person will be examined for, or commissioned a Second Assistant Engineer in said Service, who is not a citizen of the United States.

2. Candidates must not be less than 21 nor more than 28 years of age, and must be of vigorous constitution, physically sound and well formed, and not less than 5 ft. 3 in. in height.

The application for examination must be in the handwriting of the applicant and addressed to the Secretary of the Treasury. It must state the date and place of birth, and the State of which a resident. If the applicant be of foreign birth it must be shown that he is a citizen of the United States.

3. The application must be accompanied with satisfactory evidence of the good moral character and correct habits of the applicant, and certificates showing his experience either in a machine shop or in charge of a steam engine, in a technical institution, or in the engine room of a steamer, as required by paragraph 6.

4. Candidates will be required to pass a satisfactory examination as to their physical qualifications before a board of medical officers, to be designated by the Secretary of the Treasury. The physical examination will precede the professional, and should the candidate be found physically disqualified he will be examined no further.

5. To be eligible for examination, a candidate must have had not less than eighteen months' experience in a machine shop, or responsible charge of a steam engine for that length of time; or, if

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a graduate of a technical institution, he must have had the full four years' course in mechanical engineering; and, in addition to either of the three preceding requirements, he must also have had not less than six months' experience in charge of, or assisting in the care and management of the steam machinery of a *sea-going vessel in actual service.*

6. Candidates having been found physically qualified will be examined professionally by a board of engineer officers of the Revenue Cutter Service, in the following subjects, the questions and answers all being written:

(*a*) Grammar, spelling, punctuation, composition, penmanship.
(*b*) Statement of shop and engineering experiences and sea service.
(*c*) Elementary mathematics, including arithmetic, algebra, geometry, trigonometry, and use of logarithms.
(*d*) Elementary mechanics and physics, including mechanical powers, friction, laws of falling bodies, force, work, etc.
(*e*) Practical problems connected with steam engineering, such as calculation of loss by blowing off, gain by use of heaters, amount of condensing water required, safety valve problems, etc.
(*f*) Incrustation and corrosion in marine boilers, and problems connected with combustion.
(*g*) Marine boilers, description of various types, with their advantages and disadvantages, repairs to same, practical management of boilers, and discussion of accidents and difficulties, such as foaming, back draft, etc.
(*h*) Heat, steam, theory of expansion, use of steam.
(*i*) The steam-engine indicator, interpretation of diagrams therefrom, calculation of horse power, and evaporation from diagrams.
(*j*) Marine engines, description of the various types, including those used with paddle wheels, with advantages and disadvantages, special attention being given to multiple-expansion engines, practical questions relative to care and manipulation of engines, overhauling and repairs, alignments, etc,
(*k*) Valves and valve gears as applied to marine engines, including those used on side-wheel steamers, but with special attention to modern types used with propeller engines.
(*l*) Condenser, pumps, steam gauges.
(*m*) Strength of materials, including simple problems in proportions of marine engines and boilers. Inspection of materials.
(*n*) Screw propellers. Description of common types. Definitions and simple problems connected therewith.

7. The professional examination will be competitive, and all candidates who pass the minimum standard will be placed upon an eligible list in the order of proficiency exhibited by them, respectively, in the examination. From this list selections will be made in regular order, as vacancies occur, until another examination is held.

8. The standard of proficiency has been fixed at 75 per cent and candidates failing to obtain that average will be rejected. They may, however, if otherwise qualified, take another examination when the next board shall be convened. Failing in the second examination will result in the final rejection of the candidate.

9. No person shall be originally appointed to a higher grade than that of Second Assistant Engineer.

10. Any person producing a false certificate of age, time of service, character, or making a false statement to the board of examiners, shall be disqualified for appointment.

11. Any person who, subsequent to his examination, may become disqualified from moral considerations, will not be recommended for appointment.

12. All correspondence with reference to the provisions of this order should be addressed to the Secretary of the Treasury, Washington, D. C.

W. B. HOWELL, Assistant Secretary.

ON USE OF WATER-TUBE BOILERS IN THE MERCANTILE MARINE.*—II.

BY A. E. SEATON, M.C.I.N.A.

The shipping of the mercantile marine may be roughly divided into (1) passenger steamers pure and simple; (2) cargo steamers carrying passengers; and (3) cargo steamers pure and simple. The passenger steamer must necessarily be a fast one, and is usually of 14 to 22 knots speed. Its speed is dependent on its form and the power its machinery can develop. Without the fine form the largest power is unavailing for speed, and without the necessary power the fine form is useless. Fineness of form means minimum of displacement, and consequent minimum weight of hull and machinery. Great power means great weight, therefore in this class of ship everything is resolved into a question of weight. The hull of the vessel has to be designed and constructed in accordance with the rules and regulations of registries and the British Board of Trade, which circumscribe the designer. The engineer in designing the machinery is similarly fettered; but he can, by causing a small engine to work at a large number of revolutions, and by skilful design, considerably reduce the weight per indicated horse power. The great item of weight, however, is the boiler and the water contained in it. Consequently, by changing from the heavy Scotch boiler, with its mass of water, to the lighter water-tube boiler, with its small quantity of water, much more horse power can be developed in the ship, or her lines may be fined, or there may be modifications in both directions with perhaps the best results. Large numbers of passenger steamers are on short service, making daily and nightly runs of a few hours at a time, steam being raised on each occasion, and lowered when done with. The water-tube boiler accommodates itself admirably to this; and not only so, but seeing that steam can be raised in half an hour the boiler room staff of such a boat can have ample rest between the runs, besides requiring only a small consumption of fuel to raise steam, so that even if the boiler when running is not so economical as the Scotch boiler, the total result of a run of a few hours' duration is a consumption of no more coal. It is also necessary in passenger steamers that the running should be uniform. The water-tube boiler, with its very high pressure and reducing valve, permits of this, as the variation of pressure in the engine room is exceedingly slight.

With the second class of steamers, namely, the cargo and passenger boat combined, speed is desirable, but it must not be on extravagant conditions; it is usually from 12 to 15 knots; therefore any saving in weight by the adoption of a water-tube boiler would not be taken advantage of to increase the speed very largely by increasing the power, but it might, and probably would,

* Read before Institution of Civil Engineers, London, May, 1897.

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lead to an increase in speed by the fining of the ends of the ship without loss of cargo-carrying power. If, however, the owners were quite content with the speed they could effect a very considerable gain in the increased cargo-carrying capacity obtained by the saving in weight of machinery; in some trades and in some ships the difference would often mean a useful margin of profit instead of a loss. In certain vessels of this class a saving in weight of boiler would permit of the carrying of a larger quantity of fuel, which might be bought at a cheap port and enable the ship to return to a cheap port instead of being obliged to purchase it at a dear one, as is often the case now; and this without disturbing the question of cargo-carrying, so frequently a nice point with ships of this class. In the cargo and passenger steamer in short trades, the same advantages in the raising and lowering of steam would be appreciated as in the passenger ship.

In the cargo boat pure and simple, the water-tube boiler does not make such a good bid for acceptance as in the other two classes; but it still has something to offer, especially to those of moderate and small size, namely, the advantages stated above for the cargo-passenger steamer.

There are not lacking signs that the final adoption of the water-tube boiler in the mercantile marine will be preceded by the use of a mongrel form or combination of a water-tube and a tank boiler, and in some respects such a boiler is more tempting to the mercantile engineer than the pure article. Such boilers would, of necessity, contain more water than the water-tube boiler pure and simple, and consequently would not evaporate dry in so quick a time in case of the feed falling temporarily—a fear often expressed by practical sea-going men. The tank portion of the boiler with the internal tubes is also supposed to be a cure for flaming at the funnels, as well as for economizing fuel; but, when it comes, the boiler of the future will be found not to require such an appendage for either purpose. The water tube is also likely to be tried tentatively in the immediate future by fitting certain mercantile ships with an installation of half-tank boilers and half water-tube boilers, in order that the advantages of both systems may be enjoyed, viz., the rapid getting up of steam to leave port, with the bringing into action of the tank boilers later on, and the saving of a portion of the weight that is possible. Unfortunately, such an arrangement also possesses the disadvantage of both systems.

Judging by the animosity of certain inventors, one would suppose that the water-tube system was incapable of enjoying the benefits of their inventions; but this is not so; in fact, it was not certain that the definite supply of heated air is not of greater advantage to the water-tube boiler than to the cylindrical or Scotch type of boiler.

It may be asked, "Is there any reason for discarding the present form of boiler, which has done good service so long in the mercantile marine?" The same reasons which have brought about the change in warships apply equally well to a large number of merchant ships. The desire for higher pressure of steam is expressed unmistakably by every class of shipowner, as much from him who directs the great lines of ocean express steamers as from him who owns the humble trawler; and the steam-tramp managers vie with one another who shall have highest-pressed boiler. Speeds which a few years ago were deemed impossible with the largest ships are now required with comparatively small ones, and are obtained by raising the working pressure and decreasing the boiler and adopting forced draught.

A pressure of 200 lb. per square inch is not enough to satisfy the demands, and even now 250 lb. is spoken of as desirable. A Scotch boiler for this pressure, even of moderate size—say 14 ft. diameter, and having three furnaces 40 in. in diameter—will require shell plating 1 25-32 in. thick, furnaces 3-4 in. thick, and 1 1-2 in. diameter screwed stays, 7 1-4 in. pitch, with combustion chamber plates 5-8 in. thick. The shell must have treble-riveted seams throughout and double-butt straps at the longitudinal joints; the rivets will be 1 7-8 in. diameter and only hydraulic machinery of massive type can close them. The

TABLE I.

	s. s. Dido. No. 403.	s. s. Otello. No. 408.	s. s. Zero. No. 407.	s.s. Cameo. No. 457.	s. s. Hero. No. 384.
I. H. P.	2,200	2,200	1,433	1,201	1,465
Number of boilers	3 single-ended.	3 single-ended.	2 single-ended.	2 Babcock & Wilcox.	2 Babcock & Wilcox.
Size	11 ft. 6 in. by 11 ft. 4 in.	14 ft. 3 in. by 11 ft. 6 in.	13 ft. by 11 ft.	....	....
Working pressure.	200	200	200	200	200
Total heating surface	3,971 sq. ft.	6,414 sq. ft.	3,814 sq. ft.	4,400 sq. ft.	4,400 sq. ft.
Grate area	120 sq. ft.	181½ sq.ft.	108 sq. ft.	88 sq. ft.	88 sq. ft.
Weight of boilers, uptake and lagging to funnel base	100 tons.	137 tons.	76¾ tons.	....	....
Weight of hot water	40½ tons	63 "	33½ "	10½ tons.	10¾ tons.
Weight of fire mountings and bricks	9¾ "	10 "	5⅛ "	9¼ "	9¼ "
Weight of boiler mountings	4⅛ "	5 "	3⅛ "	....	....
Weight of fans, heater tubes, &c.	14¾ "	....	....	....	....
Weight of seatings.	7 "	4 "	2¼ "	4 "	3 "
Total weight of above	176¼ tons.	219 tons.	119 tons.	66 tons.	67 tons.
I. H. P. per ton	12.48	10.04	12.04	18.19	21.85

furnaces may at any time collapse should a little grease by accident get into the boiler. The combustion chamber is liable to serious bulging from the same cause; and the stays fracture if careless firemen get steam too rapidly a few times. The life of the ordinary Scotch boiler, with a working pressure not exceeding 100 lb. per square inch,

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and of which every care has been taken, is from ten to twenty years, depending on the service; that of similar boilers for 200 lb. to 250 lb. pressure is not likely to be nearly so long. That such a boiler is liable to the accidents above-named is amply proved by present every-day experience. Most of the water-tube boilers as now made, and those likely to be made in the future, will have no part exposed to heat thicker than 1-4 in., and although from the same causes accidents may ensue, they will be of a comparatively trivial nature, easily remedied, and not likely to cause serious damage to the surroundings or to life and limb.

There appear, therefore, good prima facie reasons for expecting the adoption of the water-tube boiler in the mercantile marine in the immediate future, and that satisfactory results will be obtained by its use; but caution is necessary both in the choice of design of boiler and in the arrangement of the same, and care should be exercised in seeing that such boilers are properly constructed and fitted in the ship, as well as properly looked after when there, especially as the economic working of these boilers depends so much on care and attention to details.

APPENDIX.

Table I, of the appendix, prepared by a member of the author's staff. A. H. Tyacke, shows at a glance the fullest particulars of the different kinds of boilers, as determined by their makers or advocates, for engines of 10,000 indicated horse power.

Table II, a statement of the weights, etc., of some water-tube boilers fitted by Earle's Shipbuilding and Engineering Co. into ships during the past two years, and those of Scotch boilers fitted in similar ships during that time.

TABLE II.—WEIGHTS, &C., OF BOILER INSTALLATIONS FOR PASSENGER STEAMER 10,000 I. H. P.[1]

	Closed Stokehold.	Martin.	Ellis and Eaves.	Howden.	Belleville.		Babcock and Wilcox.		Seaton.	Thorneycroft.
		Induced.	Induced.	Forced.	Forced.	Natural.	Forced.	Natural.		
Number and description of boilers	4 double-ended cylindrical.	4 double-ended cylindrical.	4 double-ended cylindrical.	4 double-ended cylindrical.	12 11-element.	18 11-element	10	12	8 double-ended.	8 single-ended.
Size of boilers	15 ft. 2 in. by 19 ft. 6 in.	15 ft. 2 in. by 19 ft. 6 in.	14 ft. 9 in. by 20 ft.	13 ft. 9 in. by 19 ft. 6 in.	4 in. element tubes 2¾ in. economiz'r.	4 in. element tubes 2¾ in. economizer.	....	....	....	....
Working pressure, boilers	200	200	200	200	200	260	200	200	250	210
Working pressure, engines	200	200	200	200	200	200	200	200	200	200
Total heat surface, sq. ft.	20,000	20,000	....	15,460	21,000	31,500	27,000	32,460	26,000	28,000
Total grate area, sq. ft	536	536	....	436	633	950	615	738	536	480
Air pressure	1—1½ in.	....	....	1—1½ in.	¾ in.	....	1—1½ in.	....	1½—2 in.	1—1¼ in.
Weight of boilers, uptakes lagging to funnel base	355 tons.	359 tons. (fan castings included).	410 tons.	267 tons.	150 tons.	206¼ tons.	200 tons.	246 tons.	155 tons	105 tons.
Weight of hot water in boilers	159 tons.	159 tons.	140 tons.	132 tons.	22 tons.	32 tons.	66 tons.	79 tons.	60¼ tons.	16¾ tons.
Weight of fire mountings and bricks	30 tons.	30 tons.	35 tons.	31 tons.	75 tons.	112 tons.	70 tons.	85 tons.	32½ tons.	25¼ tons.
Weight of steam and water mountings	5 tons.	5 tons.	5 tons.	5 tons.	6 tons.	8 tons.	6 tons.	7 tons.	6 tons.	6 tons.
Weight of fans, air blowers and heater tubes	9 tons.	9 tons castings not included.	45 tons.	7¼ tons.	23½ tons.	43¾ tons.	9 tons.	4 tons.	9 tons.	4 tons.
Weight of air-tight flats, locks, and seatings	12¼ tons.	7 tons.	7 tons.	13¾ tons.	13½ tons.	20¼ tons.	20¼ tons.	18 tons.	12 tons.	11¾ tons.
Total weight of above	570¼ tons.	569 tons.	632 tons.	455¼ tons.	290½ tons.	422¼ tons.	371¼ tons.	439 tons.	274½ tons.	168 tons.
I. H. P. per ton	17.54	17.57	15.57	21.94	34.4	23.69	26.94	22.82	36.0	59.5
Weight of funnels	18 tons.	17 tons.	16 tons.	20 tons.	17 tons.	25½ tons.	20 tons.	21 tons.	18 tons.	15¾ tons.
Weight of stokehold floor	7½ tons.	7½ tons.	7½ tons.	7½ tons.	7½ tons.	11½ tons.	6¼ tons.	5½ tons.	6½ tons.	5¾ tons.
Weight of feed pumps	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.	5 tons.
Weight of copper pipes	6½ tons.	6½ tons.	6½ tons.	6½ tons.	9 tons.	10 tons.	6½ tons.	6½ tons.	6½ tons.	6½ tons.
Weight of spare-gear	5 tons.	5 tons.	5 tons.	5 tons.	10 tons.	15 tons.	5 tons.	5 tons.	5 tons.	5 tons.
Weight of separators and reducing valves	....	....	....	....	7 tons.	10 tons.	....	....	1¾ tons.	1¾ tons.
Weight of ash hoisting-gear engine	1 ton.	1 ton.	1 ton.	1 ton.	1 ton.	1½ tons.	1 ton.	1 ton.	1 ton.	1 ton.
Weight of coal carried for 64 hours × 25 per cent.	700 tons.	700 tons.	600 tons.	475 tons.	625 tons.	750 tons.	720 tons.	720 tons.	700 tons.	725 tons.
Total weight of installation	1,313½ tons.	1,311 tons.	1,283 tons.	955¾ tons.	982 tons.	1,259¾ tons.	1,135 tons.	1,203 tons.	1,018½ tons.	934½ tons.
I. H. P. per ton	7.61	7.62	7.8	10.24	10.18	7.99	8.81	8.31	9.82	10.73
I. H. P. per sq. ft. of grate	18.65	18.65	18.03	22.91	15.8	10.52	16.26	13.5	18.65	20.62
Total heating surface per I. H. P.	2	2	1	1.54	2.1	3.15	2.7	3.24	2.6	2.8
Lbs. of coal per I. H. P. per hour	1.96	1.96	1.61	1.33[2]	2.1	1 75	2.01	2.41	1.96	2.06
Length of boiler space over bunkers	124 ft.	124 ft.	112 ft.	97 ft.	124 ft. 9 in.	145 ft.	99 ft. 3 in.	105 ft.	112 ft.	104 ft.

[1] The above weights, &c., are based on the assumption that Welsh coal is used, and that the consumption of steam for all purposes throughout the voyage will be equivalent to 16 lb. per indicated horse power per hour.

[2] This estimate of the coal consumption per indicated horse power has been supplied by Messrs. James Howden and Company. I am not prepared to say that it is verified by personal observation made from sea-going practice. The coal consumption given, viz., 1 33 lb. per indicated horse power per hour, when taken in conjunction with the water consumption per indicated horse power per hour, would mean that the evaporation of water per 1 lb. of coal would be 12.03 lb. from and at 212 deg.

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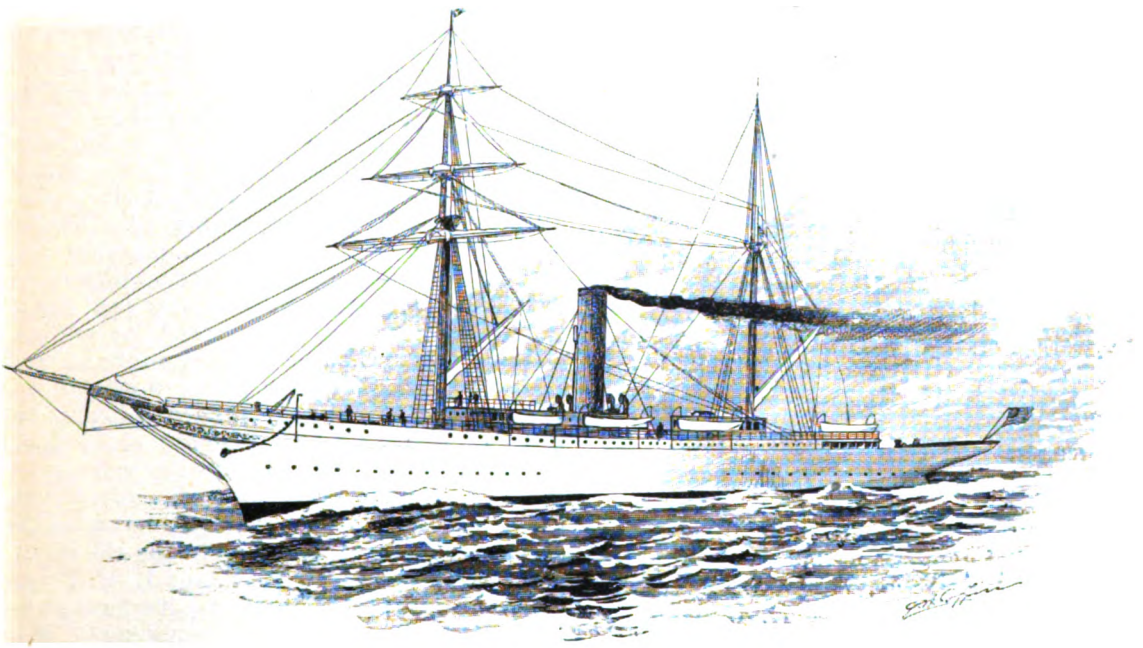
BRITISH BUILT YACHT MAYFLOWER FOR OGDEN GOELET OF NEW YORK.

Another British yacht for an American millionaire has been sent to sea recently. This is the Mayflower, designed by G. L. Watson for Ogden Goelet, of New York, and built at the yard of the Clydebank Engineering and Shipbuilding Co., Ltd. She is an expensively built vessel of 1,780 tons gross and 1,009 tons net measurement. Her length is 275 ft. on the water line, 320 ft. over all, beam 36 ft. 6 in., and depth 30 ft. to the bridge deck. The hull is divided into nine water tight compartments, so arranged that it would float though two compartments were full of water. The arrangement of decks is somewhat peculiar. There is a short forecastle, separated from a long bridge amidships by a well, but the side plating is carried in an uninterrupted line aft nearly to the end of the bridge. Here it is lowered 4 ft. on a line with the main deck bulwarks, and is carried at this level to the overhang. The interior finishings and furnishings are unusually magnificent. The reception room is on the main deck and is reached through the main gangway on the starboard side. This room is finished in oak. The engine trunk is fitted with plate glass windows, permitting a view of the propelling machinery. On this deck there are also the drawing room, 21 ft. long and extending the width of the vessel, fitted in Louis XIV style, and the library containing 2,000 volumes. Besides there are such conveniences as cloak room and bicycle store. The dining room is situated on this deck between the engine and boiler casings fitted in the style of Louis XIV. The table has a space for 24 persons, and there is a big fireplace to give a comfortable look to the room, in cold weather. Below there are six staterooms of unusually large dimensions. The woodwork is solid mahogany covered with white paint rubbed to a luster surface. Each room is fitted with running hot and cold water, water and electric heaters and electric fans, and a pipe system of ventilation. There are also placed conveniently doctor's room, maid's room, and bath rooms for guests.

Kitchen arrangements are elaborate. There is a refrigerating chamber 18 ft. by 12 ft., fitted for all kinds of provisions and kept cool by an ammonia plant installed by the Kilbourn Co., which is here used also for making ice. The pantry is laid with white tiles, and contains a hot press for heating china and keeping food warm; also a decanting table and a cold box for butter, wines, etc. There is the usual outfit of table utensils. A filter is also fitted, and an earthenware sink with hot and cold flowing water. There is also a bakery for breadstuffs. The saloon galley is fitted with a large French range, nickel plated grill and coal box, dresser and garbage dump. Special attention was given to the ventilation of the galley by natural draft and fans, and excellent results have been secured. Near the galley is the laundry, fitted with earthenware washtubs, and machinery for finishing clothes.



NEW STEAM YACHT MAYFLOWER AT SEA.

In the rooms set apart for the owner and his family the decorator and upholsterer have been especially lavish. Mr. Goelet has a large state room and bath room, and Mrs. Goelet a large state room, a boudoir and bath room, on

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the main deck. Miss Goelet has also a suite of rooms, of which the boudoir is fitted on the weather deck. In these staterooms all modern conveniences are used. Electric and steam heaters and open fires, ventilators and fans and tilting windows form contrasts for extremes of climate. There is voice pipe connection between the owner's room and the chart room, and navigating bridge. Bath rooms are supplied with apparatus for every style of spray and plunge bath. The floors and lower parts of the walls are tile laid.

A splendid promenade is provided on the bridge deck 190 ft. long and 10 ft. wide on each side of the yacht. Between the space is occupied by the machinery casings, finished in teak. The sanitary water supply tanks are also carried here. From the forward end of the promenade a staircase leads to the top of the forward deck house, which is supplied with chairs as an observation stand. Forward of this is the navigating bridge fitted with modern apparatus. The yacht's officers are housed forward below the break deck. A mess room 20 ft. by 10 ft. occupies the center of the vessel, and on either side the sleeping rooms are fitted up. There is accommodation for thirteen men. The rooms are well heated and ventilated and fitted with wash basins. Forward of this there are rooms for six under stewards and six petty officers. Below there are storerooms, ammunition room and fresh water tanks for 45 tons and a passageway leading through the coal bunkers to the fire room, so that the firemen can go forward for meals. The living room for the firemen is fitted on the lower deck between the boilers and engines. In the forecastle there is accommodation for a crew of 22 seamen.

There are two sets of propelling engines, of the triple-expansion, four-cylinder, four-crank type. The motion and cranks are so arranged as to give a minimum of vibration. The cylinders are 22 1-2 in., 38 in., and two 40 in. with 27 in. stroke. Piston valves are used on the H. P. and I. P. cylinders and Thom's patent slide valves are fitted to the L. P. cylinders. All are balanced. The valve gear is of the Stephenson link pattern controlled by a Brown's combined steam and hydraulic engine. The frames are open front with steel stanchions, the back frames carrying the condensers. Very complete auxiliary apparatus is fitted, including evaporators, feed water filters, auxiliary condenser, feed, bilge, sanitary and fresh water pumps. The electrical installation is in duplicate and gives current to about 700 lamps. Steam is generated at 160 pounds pressure in two large single-ended boilers, each fitted with four furnaces. On her trial trip the Mayflower developed 4,600 horse power and obtained a maximum speed of 16.75 knots. Her coal capacity is 530 tons, with which she can steam 2,000 knots at full speed, and 6,000 knots at 12 knots speed.

PRACTICAL APPLICATION OF MODEL EXPERIMENTS TO MERCHANT SHIP DESIGN.

To shipbuilders throughout the world, the Leven shipbuilding experimental tank used by the William Denny & Brothers is, perhaps, the most interesting apparatus possessed by any private concern. By its use the Dumbarton, (Scotland) yard has been able at times to secure results which were believed impossible. It has also been enabled, as a matter of course, to know more exactly the future behavior of any vessel whose model was made in this yard, than could be forecast by any other builder. Consequently the paper read by Archibald Denny at the engineering conference of the Institution of Civil Engineers, in London, on the tank work is of unusual interest.

The Leven tank is 300 ft. long, and for a distance of 250 ft. is 22 ft. wide and 10 ft. deep. The remaining 50 ft. is occupied by two shallow docks for adjusting the models. The tank contains 1,500 tons of fresh water, and over the water a double line of rails 3 ft. 4 in. gauge is stretched, and on this runs a dynamometer truck, and screw truck drawn by an endless wire rope. This is driven by a two-cylinder engine, with especially sensitive governor, designed by R. E. Froude, so that a practically uniform speed is secured. The tank was built in 1882, and the first experiment was made in February, 1883. The construction of the tank did not produce immediate results of a profitable kind. For four years, indeed, the work was purely experimental, no practical results being obtained. This was caused by the impossibility of correctly applying the results obtained in the tank. The relation between the resistance of the ship, or E. H. P. as shown by the model in water and the actual power of the ship on trial, was not understood. Without having a large amount of these data it was impossible to predict the efficiency or relation between the I. H. P. and E. H. P., even though it was possible to obtain the form of least resistance for any given set of conditions. When the tank was completed, however, the concern had available a large collection of data concerning actual measured mile trials, and so was able to proceed at once with investigations of the models of these vessels.

The first important result of the tank was secured in 1887, when the Belgian Government was in the market for fast sidewheel steamers for the Ostend-Dover route. The concern went vigorously to work on models for the proposed ships, the first of which represented a vessel 300 ft. long, 35 ft. wide, and about 8 ft. 6 in. draught. Results of much experimentation showed that a maximum speed of 19.5 knots could be had. Other builders had secured such a speed, however, and so the Dennys continued the experiments, and produced a model which enabled them to guarantee a speed of 20.5 knots. They secured the order for the ships, the Prin-

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cesse Henriette and the Josephine, both of which maintained a sea speed in excess of 21 knots, when built. The result was extraordinary when it is remembered that the fastest boat of the type previously built at this yard made only 15 knots. During the experiments, model paddles driven by an electric motor were tested with the hull model.

In paddle vessels the dip of the wheel had been found to be a very important consideration. Longitudinal waves, if not properly allowed for, might entirely upset all calculations, with the result of too much or too little immersion of the wheels, when at speed. With the aid of the tank it was possible to locate the exact position, depth or height, and form of wave at the wheels in the completed vessel. In the case of the Belgian vessels the depression of the wheels was about 10 in. at 20.5 knots. In the case of screw vessels also the tank was peculiarly useful in determining the form of screw best adapted to any vessel. The problem had been found to be very complex, and there seemed little possibility of being able to formulate any general rules for guidance. It had been found, however, that there is no one perfect form of ship, but that on the contrary, the form must vary with every varying condition of length, draught, displacement, and speed. The same applies to the screw also, and the screw of one vessel which had produced extraordinarily good results, would probably give as positively bad results on another form of vessel.

To further illustrate what could be accomplished with a tank, Mr. Denny related a case in which a twin screw vessel 270 ft. long was to be built with a trial speed of 17.5 knots. Circumstances made it necessary that the contract should be exceeded, if possible, so power for about 18 knots was figured on. Trial data for a very similar, though slightly larger, vessel was also available, but the new ship when tried astonished every one by giving only 17 knots, with an expenditure of power quite out of proportion to the speed. Further trials were carried out, and it was found that by trimming the vessel nearly level, instead of 18 in. by the stern, an additional 1-3 knot could be secured. This demonstrated that the stream lines aft were abnormal, and consequently tank trials were made with various types of propeller. A conclusion was reached that with a propeller of the same diameter and pitch and about 20 per cent more surface the speed, at normal draught and trim, would be increased half a knot. The change was made and the predictions verified. Another case was cited where models for sister ships were tried, resulting in the prediction of a speed of 0.3 for one vessel over the other, which subsequently was fulfilled in practice. Mr. Denny made the statement that, "No amount of investigation will even allow the laying down of general laws for producing the best form of hull and propeller without model experiments; the same routine must be gone through in each case, and before the tank can be profitably used, a store of data must be accumulated and years spent in investigation."

In the discussion which followed R. E. Froude learned that the length of the Denny models was 12 ft. At Haslar, where the British Government tank is in use, the models were 14 ft. long, sometimes approaching a ton in displacement. Paraffine wax was used for model making, which, though often costing $100 for one model, was not expensive, as one model could be melted down to make another. Paraffine wax would not swell in water, could be easily shaped, having no grain, and could be melted at a low temperature, besides being good casting material. In using the tank the same wave profile would be shown on the model corresponding to the actual ship, or, in other words, the actual effects obtained by a ship were reproduced in miniature. The disparity in size between the model and the ship necessitated the use of large multipliers, however, with a possibility of large errors. It was thus necessary to correct the deductions drawn or to confirm them by practical experience. Some shipbuilders believed they got along very well without a tank. This was so, the speaker said, for vessels could be designed on empirical data so long as builders kept to established lines. Should a radical change take place, however, the tank would be a necessity were assured results sought. The tank was also needful if a designer sought to ascertain what particular element in the design produced an improvement in trial results. It would be necessary to conduct so many experiments that only model experiments were possible if the cost was to be kept within prohibitive limits.

Prof. Biles told of a case in which the commercial value of a tank was demonstrated. A vessel of unusual dimensions and speed was desired, and its construction offered to several firms, but only one of these would accept the conditions, the Messrs. Denny. They succeeded in meeting these and were paid the highest price asked. He referred to the need of information on surface friction, and said that additional experiments were required, but on a full sized scale, using planes hundreds of feet long. He referred to the tank planned for the United States Government, which is to be larger than any in existence, so that larger models can be used. He referred also to the proposal to build a tank on the Clyde to be used in common by Scotch builders. There had been difficulty, however, in securing the co-operation of rival builders.

Sir W. H. White, chief constructor of the British Navy, believed the United States Government was right in building a tank larger than those in use. The initial expenditure of such a tank was nothing to the risk sometimes taken by shipbuilders in overstepping the bounds of experience. Referring to war ship designs he said the question of resistance was often forced aside by the important consideration of stability.

Mr. Denny, in replying, said his firm had tried

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models of various sizes from 6 ft. to 20 ft. long, and had found 12 ft. the most convenient. He agreed with the statement that the tank killed imagination, for he had early found out that what appeared to be a beautiful model, often was proven no good by the tank, and on the contrary, what looked like a wretched model, with thick middle and no ends, gave first-class results.. At the Leven tank, he said, a staff of 15 persons was employed, the yearly expenses exceeding $10,000.

Traffic in "Soo" and Suez Canals.

In a paper recently read before the Civil Engineers' Club of Cleveland, Joseph R. Oldham, N. A., made an interesting comparison between the traffic in the "Soo" and Suez Canals, with regard to the tonnage of shipping engaged in these trades.

To more readily draw a comparison between these trades, he said, I have drawn curves to a common scale illustrative of the tonnage passing the two great waterways. I also show in somber lines the still declining condition of our tonnage engaged in the foreign trade. Now it is a melancholy fact that we have not one single steamer engaged in the Suez Canal trade, therefore this comparison resolves itself, into one between the American ship tonnage passing the Sault Ste. Marie and the tonnage of other nations passing Suez. The time required for making the average voyage through the Suez canal is about twelve times as much as the time occupied in an average voyage through the St. Mary's Falls Canal. Therefore, in estimating the tonnage engaged in these trades time should be taken into account. The distance from Alexandria to Aden will be about the same as from Buffalo to Duluth. The ordinary Suez Canal trader could make ten trips from Alexandria to Aden in about the same time as it takes her to steam from London to Hong Kong, but the time required for loading and unloading is much greater in the foreign trade. If the detention in port were the same as on these waters the Suez Canal traders could make twelve trips between Aden and Alexandria in the same time as they now require to make an actual average voyage. So that their tonnage passing that point would then be twelve fold of what it now is, and if last year's clearances through the Asiatic waterway be multiplied by twelve, it represents a Suez Canal trade of over 100,000,000 tons per annum, or say 67,000,000 tons for two-thirds of a year.

There are about 2,500,000 tons of shipping regularly engaged in the Suez Canal trade. We have not quite 400,000 tons in the "Soo" trade. The average tonnage of a Suez Canal steamer is 2,460 tons, that of a St. Mary's Falls steamer 927 tons.

This is not intended to detract in the slightest degree from the fact that over 16,000,000 tons of cargo were handled and transported through St. Mary's River and Canal locks in 232 working days. The feat is phenomenal and has never before been equaled in the world's history.

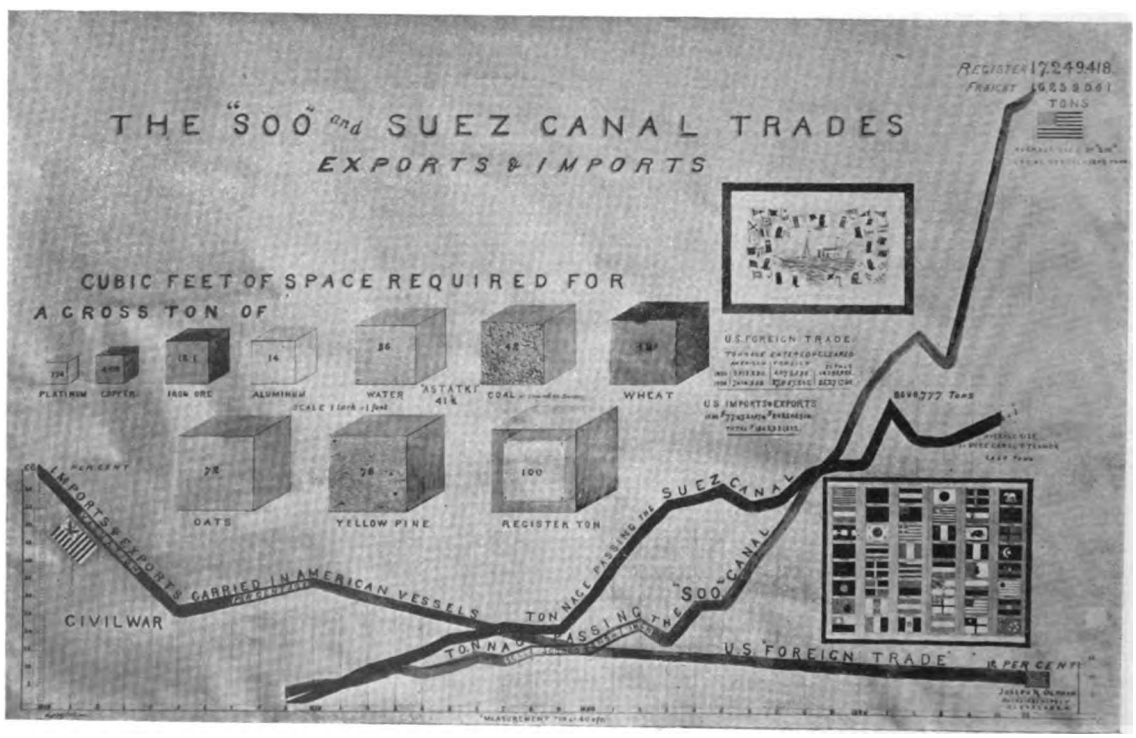

DIAGRAM SHOWING, COMPARATIVELY, TRAFFIC IN "SOO" AND SUEZ CANALS.

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IMPROVED APPARATUS.

Wing Marine Gas Engine.

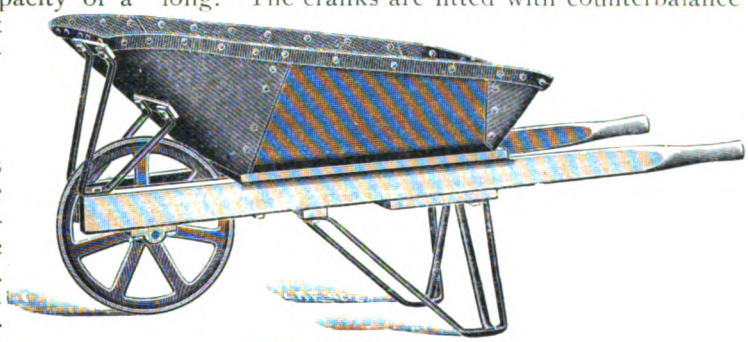
An interesting installation of auxiliary power has been made by F. L. Sheppard on a 35 ft. cat boat, which is here illustrated. Immediately under the deck in the cockpit is installed a six horse power Wing marine gas engine. No valuable space is occupied, and yet the engine is

GAS ENGINE FITTED IN SAIL BOAT.

easily reached. The screw is of the feathering type, 22 in. dia., and makes 350 revolutions a minute. Wing reversing gear is used and the thrust is a ball bearing one. The oil tank is located in the bow and has a capacity of a barrel. The hull is of the usual cat boat type, but the rig is somewhat unusual, in that a jib sail is used.

Dock Wheelbarrow for Coaling.

In order to meet the requirements of a good all-round dock barrow, the Lansing Wheelbarrow Company, Lansing, Mich., has just put upon the market the barrow illustrated herewith. Its strength and stability are self-evident. The tray is made large for wheeling coal, and the weights are so arranged that a larger part of the burden shall be directly over the wheel. The tray is placed on a board bottom and is well reinforced at the top and in front. It is made of No. 14 steel, is 18 by 24 in. at the bottom, 18 in. at the front, 8 3-4 in. at the back, length at the top 3 ft. 7 in., width at the wheel end 2 ft. 11 in., width at the handle end 2 ft. 6 in., width over all 3 ft. The capacity of this barrow is about 500 pounds of coal.



STEEL DOCK BARROW.

Four-Cylinder Four-Crank Paine Engines.

The engines here illustrated were designed and built for the new steel passenger steamer for the Woodsum Steamboat Company on Sunapee Lake, New Hampshire, by James H. Paine & Son, of Boston. There are two engines, right and left hand, the boat having twin screws; each engine having two H. P. and two L. P. cylinders. This arrangement of cylinders was adopted for the reason that the engines are handled entirely from the pilot house, levers for operating the throttle valves, and for reversing the engines, being located there. To obviate the difficulty of stopping on "centers" two H. P. cylinders were necessary unless a passover valve was also placed in the pilot house, which latter arrangement seemed undesirable. In order to keep the weights as low down as possible, the forked connecting rod which is usually used in back-acting engines was not used; but the frames were made only high enough to allow the cranks to swing clear, and each pair of cylinders was fitted with two cranks and two connecting rods. In order to occupy as little space as possible fore and aft, the L. P. cylinders were placed above the H. P. cylinders. The framing which connects the H. P. and L. P. cylinders also forms the guides for the crossheads, and the top and bottom ends of these frames serve as the L. P. and H. P. cylinder heads. Piston valves are used on all the cylinders, the valve chests being steam jacketed to ensure equal expansion of valves and chests. The valves are driven by Stephenson links, by means of rockshafts, the valve chests being placed on the side. Each link operates two valves, one H. P. and one L. P. The crankshafts are of forged mild steel, finishing 3 1-4 in. dia. Each crankshaft has five main bearings and four crank pins. The crank pins are 3 1-4 in. dia. and 3 in. long. The cranks are fitted with counterbalance weights, and during the steam test the engines, placed on the shop floor, were run at 210 turns per minute without shake or vibration. The H. P. cylinders are 6 in. dia., L. P. cylinders 12 in. dia., and the stroke is 9 in. These engines will turn a pair of "Paine" speed wheels, R. and L., 52 in. dia. and 6 1-2 ft. pitch.

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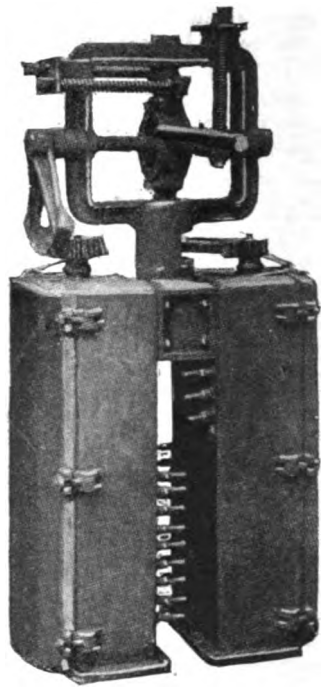
Electric Cargo Cranes, S.S. Bremen.

The steamship Bremen of the North German Lloyd line, which recently made her first transatlantic trip, is, perhaps, more fully equipped electrically than any other vessel of the merchant marine in the world. Aside from the usual electric lighting plant, she has a very complete and most novel power plant.

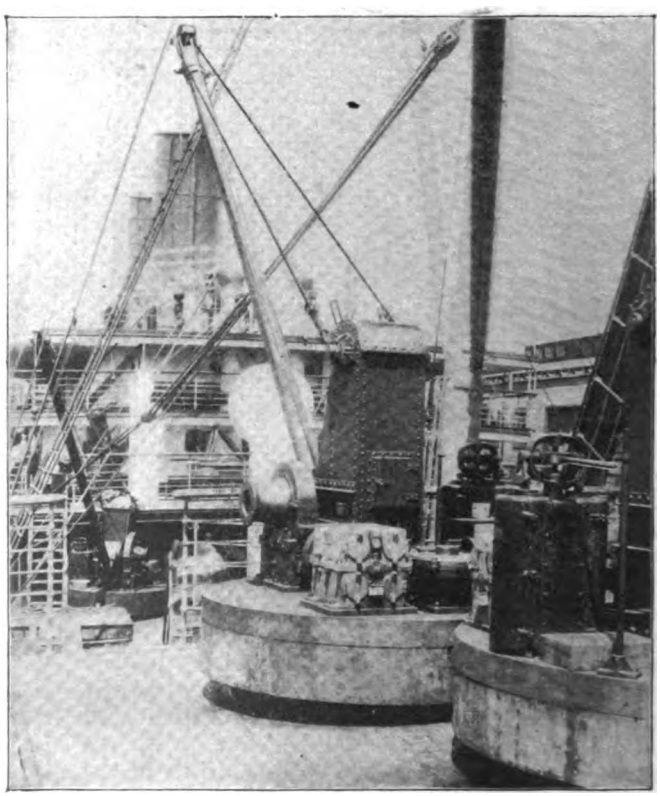
The first power installations on the steamers of the North German Lloyd were made by the Union Electricitats Gesellschaft of Berlin, the German ally of the General Electric Company of Schenectady, N. Y., on the steamships Darmstadt and Prinz Heinrich; in these two cases the familiar and noisy donkey engines were superseded by electrically operated winches, and it was the successful operation of these that determined the North German Lloyd to extend the use of electricity to the Bremen. In this case, however, in lieu of winches, a full equipment of electric cranes was installed. These cranes are sixteen in number, eight on the starboard side of the vessel and eight on the port side. Four of these have a capacity of 3,000 kilograms, or 6,614 lb., and twelve of 1,500 kilograms, or 3,307 lb., and have a total swing outboard of 20 1-2 ft.

The power generating plant is located in the after portion of the engine room and consists of four dynamos, each directly connected to its own engine. Two of these are placed on the starboard side and two on the port side. The dynamos have each a capacity of 75 kilowatts, or 100 H. P., and run at a speed of 210 revolutions, delivering current at a pressure of 105 volts. The output of two dynamos is used for the cranes; one is used for the lighting of the ship, and the fourth dynamo is held in reserve in case of accident or other emergency. The engines are of the triple expansion type and were built by Schichau, of Elbing, the port of Danzig.

The most notable feature of the electrical equipment is the cranes, the lighting installation conforming to the standard practice. In designing the cranes, the principal requirements specified and obtained were: The load should be lifted smoothly; the resistance should be so arranged that the various speeds of the motors should be obtained without too apparent and sudden change; the control of the different motions should be instantaneous and positive, these motions to be effected in the smallest possible space; the cranes to be compact and contain the smallest possible number of parts; the controlling mechanism to be of the simplest to suit the class of operators likely to handle them; and the electrical apparatus to be absolutely protected against changes of weather, inroads of dust and sea water, and to be of such a nature as to withstand rough handling. In addition, all conductors were to be carefully protected and the last consideration, but by no means the least, on a passenger carrying steamer destined



CONTROLLER WITH UNIVERSAL GEAR.



CRANES SHOWING OPERATING HANDLE.

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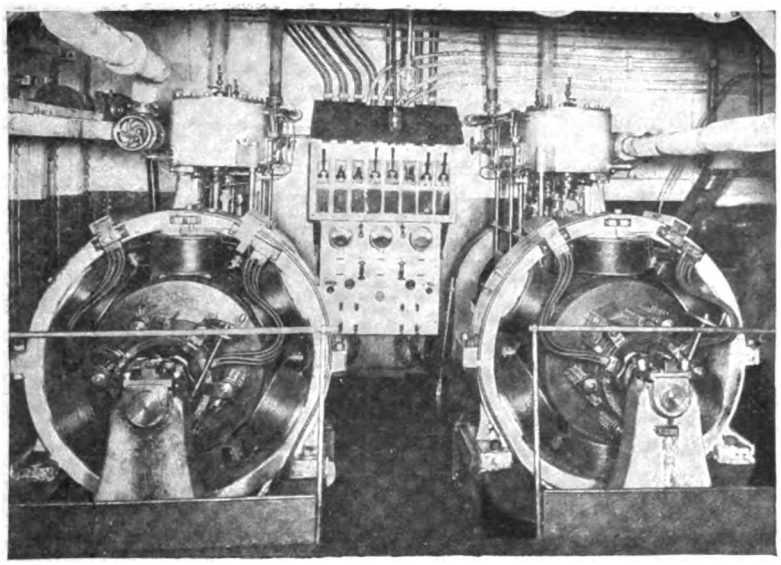
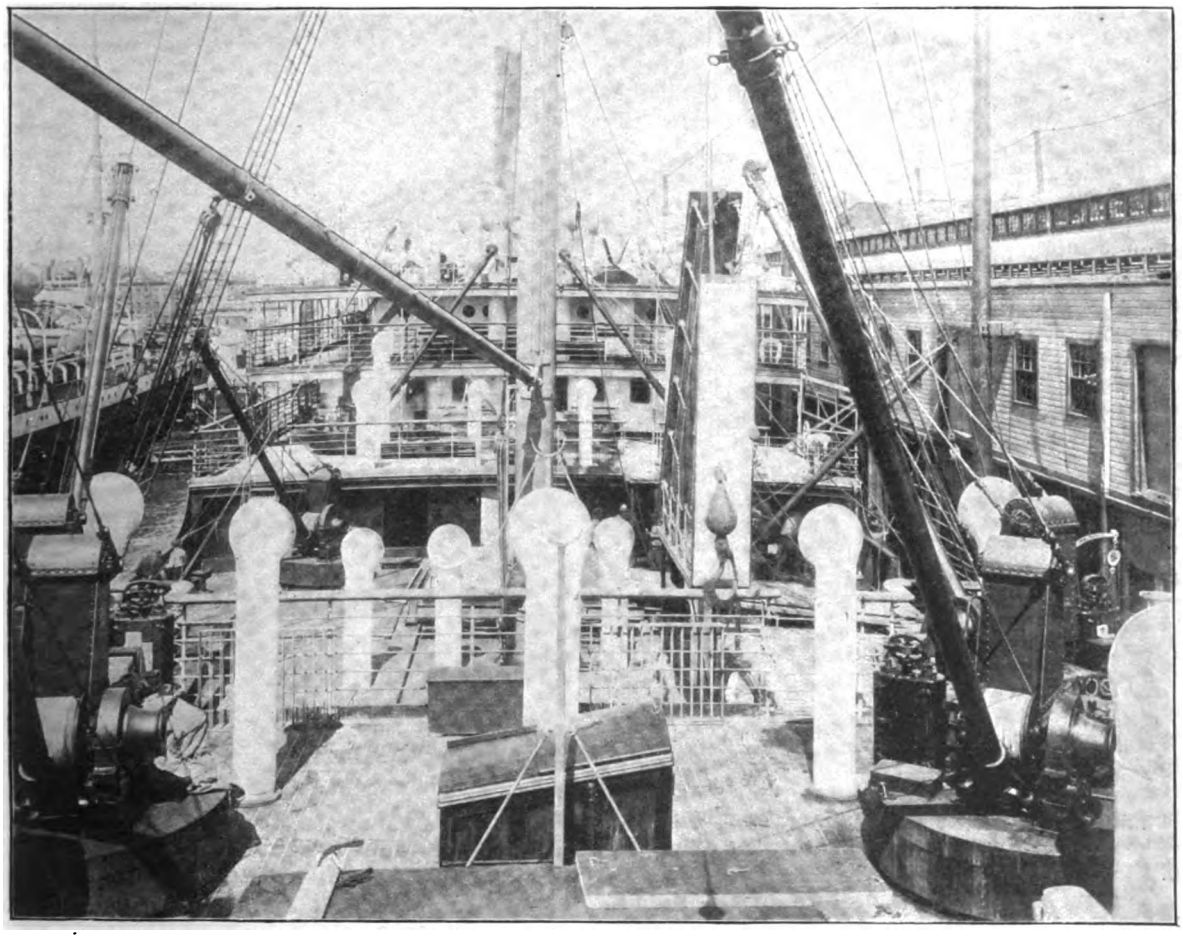


DIRECT CONNECTED GENERATING SETS, S.S. BREMEN.

to be constantly loading and unloading, the operation of the cranes was to be noiseless. In conforming to these requirements, the Union Electricitats Gesellschaft has produced what is the latest and an innovation in a ship's equipment.

The cranes, motor, and controlling mechanism



AFT DECK, NORTH GERMAN LLOYD S.S. BREMEN, SHOWING EIGHT CRANES.

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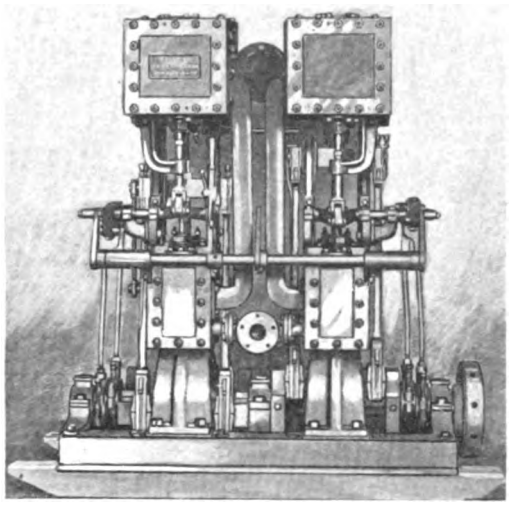
are mounted upon a circular iron platform which revolves upon a pivot. This is turned by a motor of 7 H. P. running at 700 revolutions per minute, directly coupled to a worm gear, which in turn meshes in a gearing bolted to the deck. The loads are raised by a 25 H. P. series motor,



BACK VIEW, PAINE ENGINE.

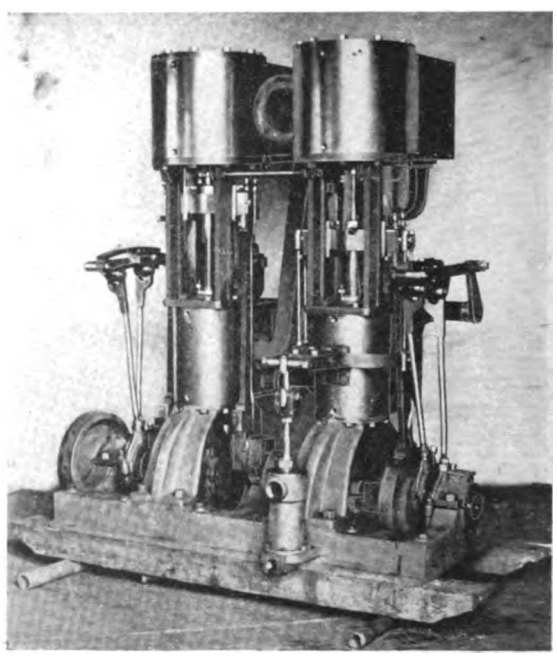
running at a speed of 900 revolutions, and driving a special worm gear meshing into the gear of the drum. On the gear end of the drum shaft is fitted a winch head. The controllers resemble a double street car controller about 2 ft. high. They are fitted with magnetic blow out, any spark being immediately extinguished in a magnetic field. The contact cylinders are operated by a special mechanism actuated by a simple handle or lever, the movements of which correspond to the movements of the load. Raising the handle raises the load, depressing the handle lowers the load, and movement of the crane to the right or left is obtained by corresponding movements at the lever. Raising and swinging movements can be effected simultaneously. The dullest stevedore can handle these cranes with ease. Motors and controllers are water tight and dust tight, but the cases of both can readily be opened when necessary. To give a more perfect control both motors are provided with band brakes operated by the foot. These brakes are attached to an extension of the motor shaft.

The difference between the large and small cranes lies in the hoisting speed. Practically both cranes are identical in electrical equipment, but the hoisting speed of the 3,000 kilogram crane at full load—60 ft. per minute—is only half that of the 1,500 kilogram crane at full load —120 ft. per minute. The movement of the jib of the cranes is 13 ft. per second.

The most remarkable feature of the cranes, however, is the absolute noiselessness of their operation. While the whole eight starboard cranes, four on the aft and four on the forward deck, were engaged in discharging cargo during a recent test, had the operation of hoisting and lowering not been witnessed, it would have been difficult to detect the fact by the ear unaided.

Electric Marine Lantern.

The signal lamp here shown represents one of the latest style of electric marine signals. It is made by Wm. Porter's Sons, of 271 Pearl street, New York. The lamp is fitted with a cast metal cap on top so arranged as to turn or revolve and thereby admit the throwing into focus of either or both electric light bulbs with which it is provided. Stuffing boxes with rubber glands are attached to the cap to prevent moisture from entering the lamp and the electric wires lead through the stuffing box and into brass tubes which support the electric lamp sockets. By this device the lights are applicable to the system of wiring the running lights in connection with an electric indicator, or tell tale. Should one incandescent lamp go out, a corresponding signal lamp in the pilot house will be lit and a bell started, and at the same time the relief lamp set aglow in the lantern, which would remain alight until the trouble would be adjusted. The inside of these lanterns is lined with corrugated metal nickled which makes a strong reflector. When these lanterns are ordered with doors, cast door frames are used, the doors



FRONT VIEW, PAINE ENGINE.

fitting snugly against rubber packing and held tight by thumb screws. Lamps of this pattern are used on the American liners, St. Louis and St. Paul, and on vessels on the Red Star line and also on the "Creole" of the Cromwell line.

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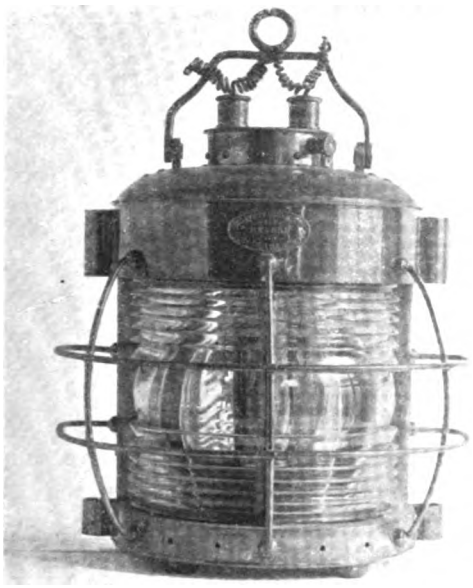
New Gas Motor for Marine Work.

One of the most recent gas or gasoline motors for use on launches and for kindred purposes, is the one illustrated herewith. It is made in several sizes from three-quarters of a horse power to two-and-a-half horse power. and is furnished complete, or in castings accompanied with work-

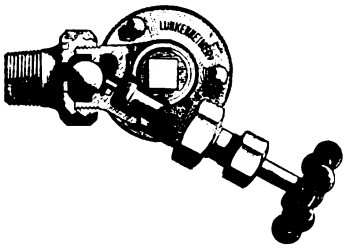


PORTER ELECTRIC LANTERN.

ing drawings enabling any expert to finish it himself. The engine is provided with a pump to circulate water in the water-jacket. These motors are built on the two-cycle compression system, with an impulse at each revolution of the crank. The charge is received through a cylinder port opened and closed by the movement of the piston, and the exhaust is effected in a like manner. A suitable valve regulates the charge received from the closed crank chamber in which the mixture is compressed by the downward stroke of the piston. Vapor and air are drawn into the crank case by the upward stroke of the piston and mixed by the motion of the crank. The one-horse power engine is seventeen inches high and weighs about 135 pounds. The compactness of the engine is self-evident. It is manufactured by the Mianus Electric Co., Mianus, Conn.

Lunkenheimer Water Gage.

This gage is so constructed that should the glass break the water will be shut off automatically. The illustration shows the construction and its operation will be readily understood. When the valves are full open and the gage glass is filled with water the pressure on both sides of the ball valves will be equal and they will remain off their seats, but if the glass breaks the sudden rush of water through the gages will cause the

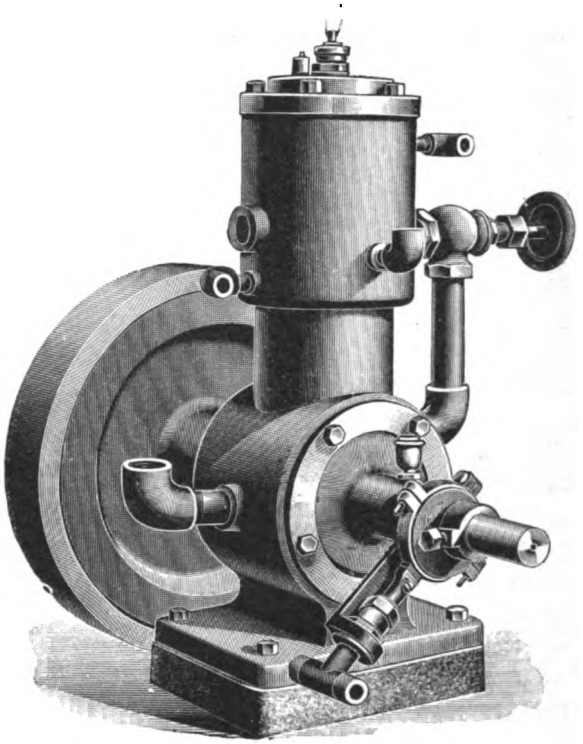


AUTOMATIC WATER GAGE.

balls to close against their seats, thereby shutting off water and steam.

The valves are placed at an offset to the body, thus placing them out of the way, which permits of renewing glasses under full steam pressure. Another feature is the method of making the gage either right or left hand, as may be desired. This is done by reversing the plugs at top and bottom of the gages, when their position can be easily changed.

While steam pressure is on, to preserve the



MIANUS GAS AND GASOLINE ENGINE.

automatic feature the valve stems of both gages should be screwed back as far as they will go, so as to allow the ball valves to act promptly when occasion requires.

The Lunkenheimer Co., Cincinnati, Ohio, is the manufacturer.

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Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

Whether or not the fast transatlantic mail service between Canada and the mother country, which has lately been arranged for, will materialize seems to be an open question. It will be remembered a contract was closed on behalf of both Governments with the firm of Peterson and Tate, of Newcastle-on-Tyne, England, for the equipment of the line with steamships of not less than 10,000 tons displacement, and having an average speed of at least 500 knots in 24 hours. This, of course, is a big order for any firm to carry out, and especially for one which does not appear to have had any previous connection with the management of large fast mail boats. It is estimated that the cost of four such vessels would be between nine and ten millions of dollars. The firm is interested in a fleet of freight steamers sailing out of Newcastle-on-Tyne, built upon what is known as the "turret" system. This design is said to be that which will be adopted in the construction of the new ships. Plans for vessels 530 ft. long, 64 ft. beam and of 14,000 tons displacement are said to have been considered favorably. In these the application of the turret method of construction gives a bottle-necked cross section in which the top is about 40 ft. wide and the shoulders on each side, extending the length of the vessel, 12 ft. wide. The promenade and boat decks would probably extend beyond the width of the "turret" to the sides of the hull, which would certainly be a very flimsy arrangement for vessels built to withstand North Atlantic gales. But this is assuming that the ships will be built and put in service. Some influential English critics express a disbelief in any such outcome of the present negotiations. They produce figures to show that even with the aid of the subsidies granted by the Dominion and British Governments, amounting to about $800,000, such a line would not be profitable to the stockholders. It is possible, however, that these utterances are inspired by vested interests, for existing lines can hardly view such competition with complacency.

"We knew how it would be." This is the opening sentence in a paragraph which appeared in a recent issue of the London Engineer, stating: "It was not to be supposed that the United States press would admit that England could produce a faster vessel than America." This is the same paper, we believe, which took elaborate pains to demonstrate that American locomotives could not do what they were really doing every hour in the twenty-four. In the paragraph referred to the Engineer proceeds to quote the "St. Louis Journal," to the effect that the Mosher steam launch Ellide, tried on the Hudson recently, is "faster than any vessel afloat in the world and eclipses the speed record of the Turbinia." It is remarkable that our London contemporary did not quote what the Brattleboro Holstein-Friesian Register had to say about the comparative speeds of the boats. So far as we know, neither the designer of the Ellide nor a single authoritative paper in this country made any such assertion. On the contrary, the technical press generally and many of the daily newspapers gave full recognition to the performances of the Turbinia. We do not know what the Ellide is capable of doing for the official trial trip has not taken place, and possibly she can wash the Turbinia on a measured mile run. The profession and practice of engineering is world-wide and all the talent and skill which makes for progress is not confined to England or America, or any one other nation. In no country is this better appreciated than here, and in no country is genius, whether of home or foreign origin, accorded quicker or more proper recognition. Regarding this splenetic paragraph, we should like to be informed whether the London Engineer read the article it quotes from in the St. Louis Woman's Farm "Journal" or the "Journal" of Surgery and Gynæcology.

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The Marine Journal wants to know why papers use the term "pleasure yacht" in describing what our contemporary considers is just a plain "yacht" One reason probably is that a newspaper is published for the information of its readers and not for the perpetuation of any strictly technical modes of expression. Anyhow, there are yachts and yachts. Would any person call the Defender or Valkyrie III. a "pleasure yacht"? We think not, unless one of those peculiarly constituted persons who in this age of power prefer to sail in a roundabout way to their destination rather than steam direct. There are hundreds of such vessels, large and small, in existence all over the world where yachting is understood, and they are generally known as "racing yachts." Only the very barest accommodations are fitted in them for the use of the crews. As to steam yachts there is a class of vessels abroad known as "Royal yachts." These in some notable instances are used as despatch vessels or ferryboats. In other instances they are built from designs which represent a cross between a liner and cruiser, and are intended to be used offensively in time of war. It seems to us that, everything considered, the use of the term "pleasure yacht" is quite admissable, just as proper, indeed, as saddle-horse or pack-mule.

What could the "enterprising" daily newspapers of the country have been thinking about in letting the loss of the Russian ironclad Gangout pass without extended comment. Had an American warship fouled a can-buoy, for instance, it would surely have formed the text for a library of "news" articles. The loss of one of Russia's powerful warships called for an obscure paragraph only. The Gangout was built in St. Petersburg in 1890. She displaced 6,592 metric tons and with 8,300 horse power attained a speed of 14.7 knots. She was strongly armored and powerfully armed. She was supposed to have been lost by striking on an uncharted reef in the Gulf of Finland. Later reports, however, indicate a mysterious cause of disaster, as her navigating officers are credited with saying the shock was so slight as to be almost imperceptible, and she kept afloat for several hours afterwards. She is said to have been structurally weak. The loss will be about $5,000,000, but a private company has offered to raise her. She lies in only fifteen fathoms of water. The estimate for the work is $1,500,000.

ON THE USE OF A DECIMAL SYSTEM IN ENGINEERING PRACTICE.

The substitution of a decimal system of measurement in engineering practice for the present standard measures is a subject of frequent discussion both here and in the United Kingdom. The advocates and opponents of a change usually express opinions rather than state facts. Consequently the actual experiences gained in a shop where the change has been made are of especial interest. These are embodied in a paper read by H. R. Sankey, M.I.C.E., before the recent conference at the Institution of Civil Engineers in London. The works referred to is that of Willans & Robinson, which has always been noted for exact work. Broadly speaking, says Mr. Sankey, the decimal system is used in engineering in the United Kingdom whenever calculations other than mere checking have to be made, or when very accurate dimensions have to be expressed; and in either case, in mechanical engineering, the decimals are generally those of the inch, its square or its cube. The reason of this is fairly obvious. As regards calculations, decimals are, on the whole, far simpler than vulgar fractions, and they allow of the ready use of the slide rule or tables of logarithms.

It is true that occasionally simple vulgar fractions have to be dealt with, as, for instance, 1-6 in the case of the formula for the strength of a rectangular beam. In such cases the vulgar fraction would obviously be used; to convert to decimals would correspond to using a slide rule or a book of logarithms to multiply 6 by 5, or some such simple sum.

In the case of accurate dimensions in mechanical engineering, 1-64 in. is far from being a sufficiently small dimension; hence the use of the terms bare and full; and as, for interchangeable work, such vague dimensions are very unsuitable, recourse is naturally had to the use of 1-100 in. and 1-1000 in. The writing down of accurate dimensions is also very cumbrous, even when they can be expressed by 1-64 in.

Compare, for instance, 11 in. + 15-16 + 1-32 + 1-64 in. bare with its decimal equivalent 11.98 in. No doubt the same dimension may be more briefly expressed at 11 63-64 in., but this form is not generally used in practice, and there are obvious reasons why this should be so.

It will be observed that the decimal expression has only been carried to the second place, and this is because the uncertainty in 1-64 in. "bare" is of the order of 1-100 in. If the decimal expression is extended to the third place, an order of accuracy is reached, expressed by 1-1024 in. on the binary scale, fractions which are not practically workable.

When dimensions of no special accuracy have to be stated, the natural tendency to successively divide the unit by two gains the upper hand. Notwithstanding this tendency and the prevailing custom, it can scarcely be doubted that it would be preferable to state all such dimensions in decimals of an inch.

If decimals of an inch are adopted, the system is still incomplete, owing to there being 12 in. to the foot, 3 ft. to a yard, and so on.

It is here that the metric system has a great advantage; it is a decimal system throughout. As experience in such a matter has more value than mere theory, a statement of the results of introducing the metric system of linear measurements into the works of Messrs. Willans and Robinson may be of interest.

In the first place, it is desirable to say a few words about the class of work and method of manufacture carried out at the works in question.

The Willans central-valve engine and the Niclausse water-tube boiler are manufactured each in certain definite standard sizes, and the parts required are made to gauge and template in large batches and have to conform to fixed dimensions within specified limits of accuracy, in order that strict adherence to the interchangeable system may be maintained.

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In the machining and examination of the parts gauges and templates are used, as far as possible, to the exclusion of the measuring rule. Whether inches or millimeters are used is, therefore, not a matter of much importance.

At the marking-off table the measuring rule is, of course, more used, and the question of convenience in the unit of measurement, and its divisions, is of greater importance; the parts are, however, dealt with in batches, and the convenience or otherwise of the unit of measurement, and its divisions, tells once only for each dimension for the whole batch.

The circumstances that led to the adoption of metric linear measurements are not of general interest, and for reasons which need not be entered into here they were only applied to the Niclausse boiler, and to certain sizes of the engine; the earlier sizes being still made to drawings figured in feet and inches. Thus the two systems are concurrently at work in the same shop.

There would have been no advantage in re-figuring these drawings with equivalent millimeters, and to make new parts to millimeters to interchange with old parts made to inches would be impossible without going to several places of decimals. The old gauges and templates were marked with the millimeter equivalent to the third place of decimals, but this was merely to accustom the men to sizes expressed in the new system. It may be mentioned that the men were supplied with rules marked with millimeters on one side and inches on the other.

The expense involved consisted principally in providing a complete set of gauges. New templates and jigs had also to be made, but only a portion of their cost is properly chargeable to the introduction of the new unit, as the greater number of them would have been required in any case.

The only difficulty met with has been in connection with the screw threads. Hitherto, the ordinary Whitworth and gas threads have been retained, but, for reasons connected with the manufacture of the engines abroad, the body of the bolt or stud is turned larger than usual, the excess being 0.3 millimeter for 1-2 in. Whitworth, and 2 millimeters for 1 1-2 in. Whitworth. Intermediate sizes are in proportion, all being brought up to even millimeters. The bored holes are then able to take the corresponding screw cut to the standard used by the French makers of the engine, who use the thread of the Société d'Encouragement, which is slightly larger than the Whitworth, and which, it is stated, promises to become universal in France; it is now adopted by the French navy and railways.

The metric dimensions were introduced in May, 1893, and, after four years' working, the following is the result:

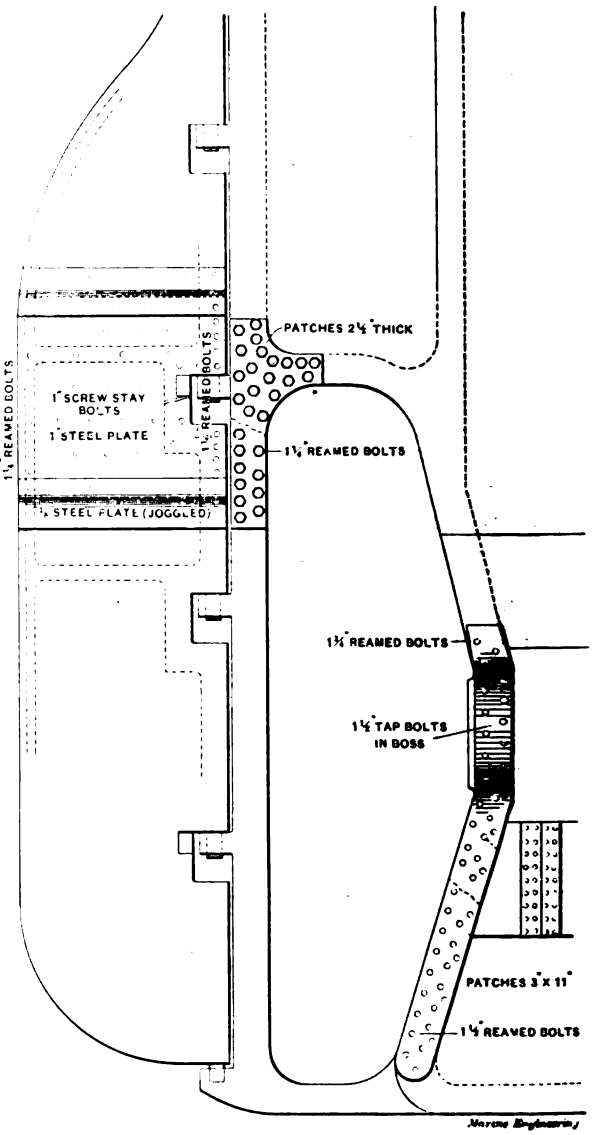
No difficulty has been experienced in getting draughtsmen to use the new measures. No serious mistakes have been traceable to the change, and very few minor ones. The draughtsmen are practically unanimous in favor of metric measures, finding it easier to design, to check, and to read millimeter drawings. Taking all fractions in account, little more than half the number of figures formerly used are now required to express a dimension. An average case would be 3 ft. 1 3-8 in., which, on a millimeter drawing, would be figured 949, and an extreme though possible case is 3 ft. 1 3-32 + 1 1-61 in. bare, which becomes 942.4.

The need to use decimals of a millimeter is very infrequent, but in the case of inches the use of fractions is, of course, the rule. A cylinder, for example, might be figured 2 ft. 6 in. on an inch drawing, and 770 on a millimeter drawing. The piston body must have a certain clearance, say 1-32 in. in one case, or 1 millimeter in the other, in which case it must be figured 2 ft. 5 15-16 in. on the inch drawing; whereas, on the millimeter drawing, the dimension becomes simply 768, and the use of fractions is wholly avoided.

The proportions between dimensions are more readily appreciated when expressed in millimeters. Thus the ratio between 27 millimeters and 49 millimeters is much more easily apprehended than between 1 1-16 in. and 1 15-16 in.

A point of some importance is that the ordinary foot and inch ticks or marks are not required, and with them disappears the possibility of having 2 in. added to each 10 in., or deducted from each foot in a dimension. A case of this kind occurred in which two 13 in. flanges intended to come together were shown on different drawings; in one of them a tick was introduced after the one, and that flange was made 1 ft. 3 in.

With millimeters a cipher might possibly be put in or omitted, but a dimension ten times too big or too small would at once be noticed as absurd.



REPAIRS TO STERN FRAME AND RUDDER, S.S. BARBARA.

In the drawings, scales 1, 1-2, 1-5, 1-10, and occasionally of 1-25, 1-50, are used. It is found that this number of scales is amply sufficient.

In the works manager's opinion, the metric system would prove even more advantageous in shops where measurements are taken from the rule than where gauges are used. He considers it easier to teach men the use of the rule with the metric than with English measures.

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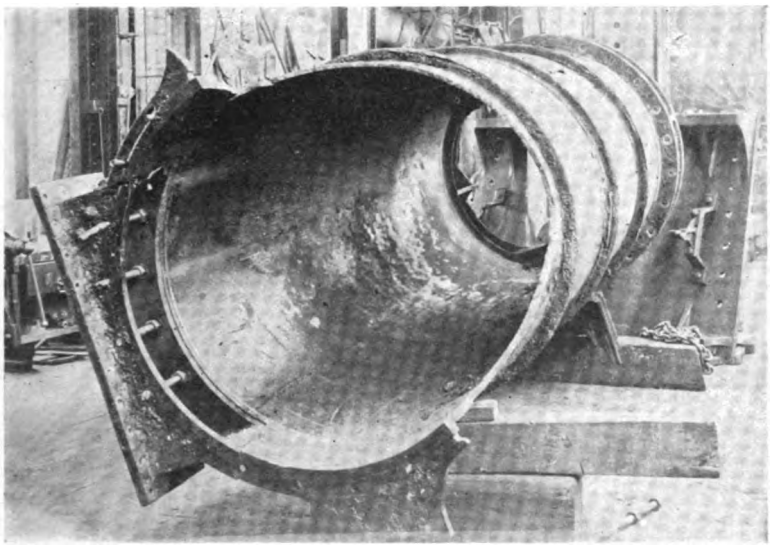
MISHAPS AND REPAIRS.

Repairs to Stern Frame and Rudder.

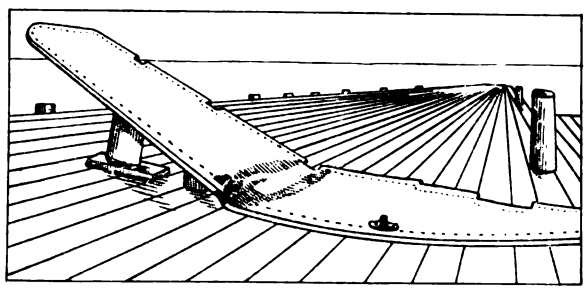
New Orleans marine interests are very proud of the success of a heavy repair job to the British steamship Barbara, recently executed by the Schwartz Foundry Co. The Barbara is a steel vessel of 3,740 tons gross and is 340 ft. long, 47 ft. wide, and 19 ft. deep. When leaving fully loaded she ran aground at the head of the Jetties, and her stern swinging round came into contact with a pile of rock. The stern frame, rudder, and abutting skin plates were broken and badly twisted, the rudder bent to an angle of about 30 deg. She was hauled off by tugs and towed back to New Orleans. There was a good deal of hesitation about undertaking the repairs at the port, owing to lack of a dry dock. George Brew, the Boston representative of the owners, who had been telegraphed for, decided to attempt repairs by using a floating stern dry dock which was borrowed from the Morgan line. This was too small for a vessel of the full lines of the Barbara, and consequently divers were sent down and templates made of the cross section near the stern. The ends of the floating dock were cut to suit, and when the water was pumped out, a fairly tight fit was the result. Bids for the work were called for and a contract let to the Schwartz Foundry Co. The broken frame, which weighed 17 tons, was removed and taken to the shops of the contractors, and there with the other damaged portions bent back to shape again. The breaks are shown in the accompanying drawing, together with the scheme of repair. These fractures were covered with steel plates and riveted in place. The rudder was also strengthened in a similar way, and new plates were riveted on the bottom to replace those damaged. Work was carried on night and day and it was greatly expedited by the use of electric drills, the current being taken from a neighboring trolley line. When completed the job was thoroughly satisfactory and the steamer loaded a cargo of grain for a British port. Joseph Blackett, of London, a marine surveyor, who was sent over by the owners to superintend the work, expressed his entire satisfaction, both with the quality and cost of the job, which occupied just 19 days.



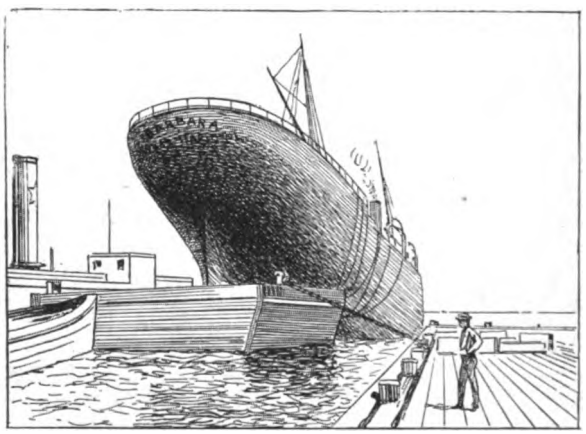
BROKEN CYLINDER, S.S. STATE OF OHIO.

Smash-up of Beam Engine.

An unusually bad smash up occurred recently on the lake steamer State of Ohio, the results of which are here illustrated. The vessel is 1,200 tons gross, and 225 ft. long. The engine is of the ordinary beam type with cylinder 50 in. dia. and 132 in. stroke, working at about 50 lbs. pressure and making about 27 revolutions per minute. The smash-up was caused by the breaking of the main connecting rod at a point about 5 ft. below the center. In an instant the engine was a wreck, the parts which were smashed including the beam skeleton, beam pillow blocks, front links, cylinder and heads, condenser and bed plate, piston rod, cross head and guides, air pump and hot well, and the air pump bucket and crossheads. The cranks were also started on the shafts, one wheel was shaken loose, and the crank pin sprung. Repairs in the ordinary sense could not be carried out, so the engine was practically rebuilt. The only parts used again were the shafts, wheels, and cranks, with their pillow blocks. The work was done by the Detroit Dry Dock Co., under the direction of Frank E. Kirby, and with such speed that only 29 days elapsed from the time the steamer arrived at the yard until she was again in commission. Not only were the new parts speedily made in the shops, but the time occupied in erecting the engine in the boat was only 8 days and 8 hours.



DAMAGED RUDDER, S.S. BARBARA.



S.S. BARBARA IN STERN DRY DOCK.

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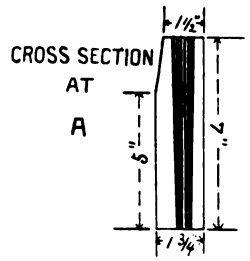
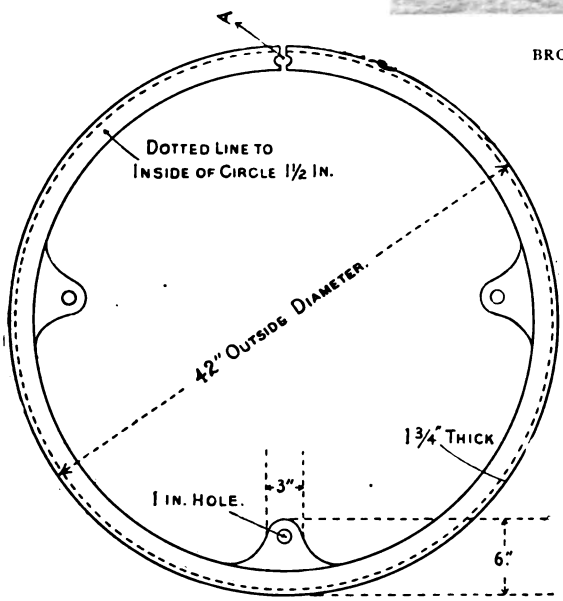
CORRESPONDENCE.

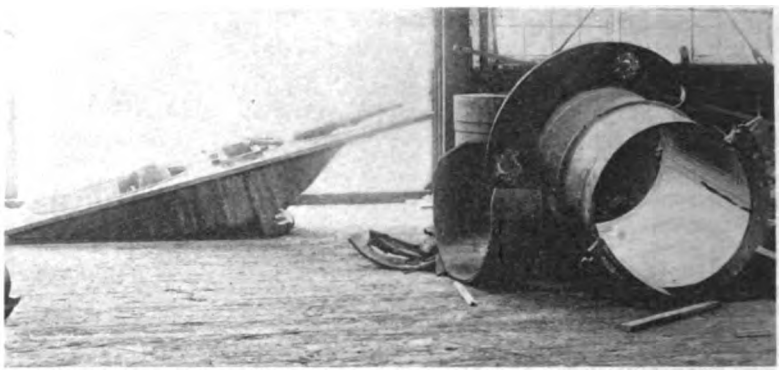
[We do not assume responsibility for the opinions expressed by correspondents.]

Handy Tool for Marine Boiler Shops.

I saw a device recently in the boiler shop at the Brooklyn Navy Yard which struck me as a very simple and efficient addition to the shop tools. I send you a sketch of it which makes the construction clear. Rings of this sort are used to true up the furnace mouths in boiler ends and from the samples of work I saw they are very effective. After the end is flanged for the furnace mouths, it is of course badly buckled and is put in the annealing furnace so as to heat all parts evenly. These rings are slung, by the lugs cast on the bottom, over the block at the mouth of the furnace. Then the plate is hauled out and leveled with mauls. When it is squared up the rings are lowered by tackle into the flanged furnace mouths in the plate and an iron pin is driven into the hole in each cast iron ring, so that the ring fits the opening snugly. Then the boiler end is left to cool and the flanged mouths contracting around the metal rings make true circles. When cold the pins are driven out of the holes in the rings and the rings are lifted out easily. It makes a nice job and saves a lot of trouble and possible reheating. I learned that the scheme originated with the foreman of the boiler shop, John O'Rourke. The rings can be cheaply made in the foundry and have only to be turned true on the outside, and they are practically indestructible.





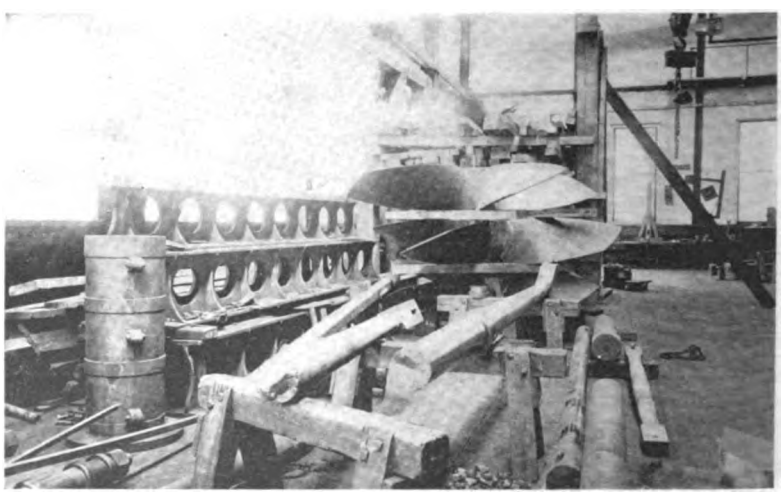


BROKEN AIR-PUMP AND FRAME, S.S. STATE OF OHIO.

SCOTCH BOILER.

A Question of Boiler Economy.

I have heard it stated that the water-tube boiler only requires a small consumption of fuel to raise steam, but that when running it is not so economical as the Scotch boiler. Now, what I should like to know is why a water-tube boiler is more economical than a Scotch boiler in generating steam, but less economical in maintaining it. I understand that in the former there is less water to be heated, but if this is an advantage at the beginning of a trip, why isn't it a disadvantage at the end? That is, I should think the water-tube boiler would need firing up to the last minute of service, whereas the Scotch boiler, if slow to heat, should be equally slow to cool, and it would seem could furnish steam for a long time without additional firing at the end of a run. J. H. P.



BROKEN CONNECTING ROD, S S. STATE OF OHIO.

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Disposal of Excess Feed-Water.

I recently came across the June number of your publication, and becoming interested, have subscribed and purchased the back numbers. In the correspondence column of the April issue I notice a communication signed "E." regarding the disposal of excess salt water which finds its way into the hot-well through leaks in the condenser tubes. Two methods of disposing of the excess are proposed: First, putting the whole quantity into the boilers and blowing off to get rid of it, and, second, allowing the excess to escape from the hot-well. In either case a certain amount of salt gets into the boilers, but it is admitted that the increased density due to this may be disregarded as not being dangerous. It is supposed that the excess water leaking into the condenser is 5 per cent of the total amount of water fed to the boilers. In this case, I do not believe that there would be any great excess to dispose of, as the leakage here and there from stuffing boxes, joints, etc., is probably about 5 per cent of the original amount of feed. However, we will assume that the actual excess is 5 per cent of the total boiler feed. It seems to me that the proper method is to use a compromise of the two methods mentioned, and as the boilers must be blown off occasionally, to feed enough of this excess to make up the amount blown off and to allow the balance to escape from the hot-well. It hardly seems advisable to heat all of this excess up to boiler temperature and then blow it off simply to get rid of it.

Let us assume that we have 6,000 horse power of engines using 15 pounds of steam per horse power per hour at 160 pounds gage pressure. Then we will require for our engines 6,000 × 15 = 90,000 pounds of steam per hour, and allowing about 10,000 pounds per hour for all the auxiliaries, we will require in all 100,000 pounds of steam (or feed water) per hour. Five per cent of this is 5,000 pounds per hour. In one pound of the water of steam at 160 pounds pressure there are 343 heat units above 32° Fah. We will assume that the temperature of our hot-well is 122° Fah., or 90° above the freezing point. Then to bring one pound of this excess water up to gage pressure we must supply 343 minus 90 = 253 heat units and for the total excess of 5,000 pounds we must supply 5,000 × 253 = 1,265,000 heat units per hour. In one pound of coal there are about 13,000 heat units, and assuming the efficiency of the boilers at 65 per cent, there are available for each pound of coal burned 13,000 × .65 = 8,450 heat units. Then the amount of coal required to bring 5,000 pounds of water at 120° Fah. up to the temperature of steam at 160 pounds pressure equals $\frac{1{,}265{,}000 \text{ B. T. U.}}{8{,}450 \text{ B. T. U.}}$ = about 150 pounds per hour. In a ten-day run we have 240 hours, and we would use for this purpose 240 × 150 = 36,000 pounds of coal in heating this 5 per cent excess feed water. If the amount of water wasted in blowing off is 2 per cent of the total feed, and we supplied this from our excess, we would still be heating unnecessarily 5 per cent minus 2 per cent = 3 per cent of our feed water and in doing so, we would use 3-5 of 36,000 pounds of coal, 21,600 pounds, or about a ton per day. This assumes that none of this excess is evaporated into steam, but is only heated up to boiler temperature. While this is not a large amount it is certainly an appreciable unnecessary waste. I would be pleased to hear from other engineers on the subject.

Wish you the success which your paper merits.

H. R. J.

Another rumor that China is soon to purchase a new navy has been started by the foreign press.

Contracts for the construction of the three new torpedo boat destroyers for the navy have been let by the Secretary of the Navy. These nrms will build one each: Harlan & Hollingsworth Company, Wilmington, Del.; Gas Engine & Power Company, Morris Heights, N. Y.; Wolff & Zwicker, Seattle, Wash.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—II.

BY WM. BAXTER, JR.

In all the figures given, so far, to illustrate the action of magnetism, the force has been shown as acting along curved lines. Some persons find it difficult to understand the real meaning of these lines owing to the fact that they are accustomed to see magnets draw pieces of iron in a direction nearly perpendicular to the surface of the bar at the particular point where the object is attracted, and therefore do not understand how the curved lines can represent the direction in which the magnetic force acts. To be able to interpret this apparent discrepancy it is necessary to take into consideration the fact that when the magnet acts upon a piece of iron that is free to move in any direction it will be drawn toward the magnet by the combined action of the attraction from both ends. The curved lines represent the direction in which a small magnet ueedle will be directed if it is held so as to swing freely around its

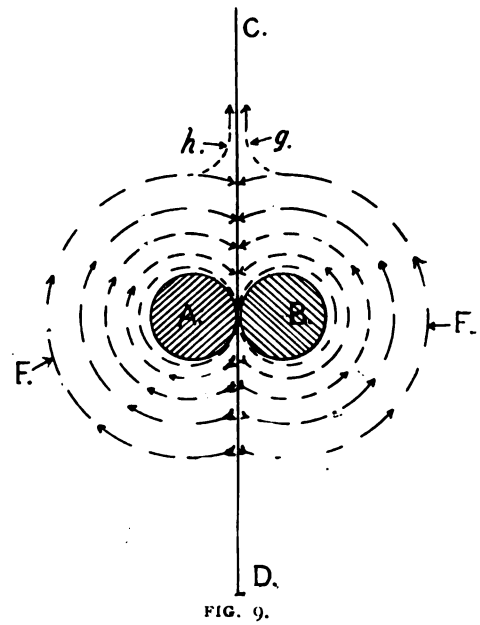

FIG. 9.

center, but at the same time so as to not be drawn bodily into the magnet. This method of representing magnetic force by curves came into use from the fact that the action of the force along such curves can be demonstrated by very simple experiments. If you place a sheet of card board over a magnet, and sprinkle upon it some iron filings, you will find that if the card is jarred gently for a few moments, the particles of iron will begin to arrange themselves in curved lines extending from one pole of the magnet to the other. If a wire carrying an electric current is passed through the card, the latter being in a horizontal position, the filings will arrange themselves in circles concentric with the wire.

These lines along which magnetism acts are called magnetic lines of force. The total strength of a magnet is spoken of as the total number of lines of force, or the magnetic flux. The region in which the force acts is called the magnetic field. Theoretically, the field of any magnet is unlimited, if not neutralized by a counter-acting field, but in practice the field is regarded as the space immediately surrounding the magnet, or electric current, except in the case of telephones and telegraphs, where, under some con-

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ditions, the effects of the magnetic field can be detected at distances of several hundred feet.

Although magnetism is a static force, it acts in many respects as if it flowed in currents, and on that account the terms magnetic current, magnetic circuit, magnetic flow, etc., have come into extensive use, but it should be remembered that their use is only a convenience. If the path traversed by the lines of force is long and contracted in cross section, it will offer a greater resistance to their passage than if short and of abundant cross section. In this respect the action of magnetism resembles the action of water flowing in a pipe, the longer and smaller the pipe the greater the resistance the water encounters. With a given pressure to force the water through the pipe, the quantity forced through will be dependent upon the length and diameter of the pipe. Shortening it will increase the flow and increasing the diameter will accomplish the same result. This is also the case with magnetism, if we have a given magnetizing force the strength of the magnetism developed or number of lines of force will depend upon the length and cross section of the magnetic circuit. If the length is reduced and the cross section is increased the lines of force will be increased. If water is forced through a pipe having a rough surface, it will not flow as freely as if through a highly polished pipe. If magnetism is forced to pass through air it will not pass as freely as through iron.

From the foregoing comparisons we can see that there is a great similarity between water flowing in a pipe and magnetic action in a magnetic circuit. The flow of water with a given pressure is dependent upon the length of the pipe, its diameter and the character of its surface. The magnetic force developed by a given magnetizing force is dependent upon the length of the magnetic circuit, its cross section and the character of the medium through which the lines of force pass.

With the assistance of these explanations we can proceed to show how, under certain conditions, electric currents may traverse wires and not be surrounded by a magnetic field, as was stated in the first article. In Fig. 8, of that article, the lines of force are shown around two wires running parallel with each other and traversed by currents flowing in opposite directions. As the current in the two wires runs in opposite directions, the lines of force around them must be oppositely directed, but from this fact the flow of the lines in the space between the two wires will be in the same direction, just as two gear wheels roll together although the shafts revolve in opposite directions. As the lines of force are in the same direction, they will not counteract each other, but the cross section of the space through which they must pass is restricted by the distance between the wires, and if this is made very small, the contraction will greatly increase the resistance the magnetism has to overcome, the consequence being, that the number of lines of force will be reduced. Suppose the wires are brought as close together as possible without actually coming in contact, as shown in Fig. 9, then, as there will be practically no space between them, there will be no way for the lines of force to get through, and, therefore, there will be no magnetism circulating around them, so far as that passing through the space between the wires is concerned. From the direction in which the arrow heads point, in the figure, it will be seen that the balance of the lines check each other where they meet, at the line CD. If, when the lines meet head on, at this line, those marked E should endeavor to curve up, as at G, and thus get by the barrier, they would find that those from the opposite side were endeavoring to do the same thing, as indicated at h. The condition above explained can be brought about practically by arranging a wire as shown in Fig. 10. As can be seen from the figure, the current in the two parts of the wire will run in opposite directions, as in the region between the lines CD and EF there will be no magnetic field practically. Above C the wires will be surrounded by magnetic lines of force owing to the fact that there is a space formed by the loops through which they may pass. The greatest density of lines will be along the line A. Magnetic fields will also be developed around the wires between the lines D E as there is also an opening at this point. At D and E the field will be very weak and will increase gradually toward the line B where it will be the strongest.

Since lines of force surround a wire in which a current flows, and are not present when there is no current, we must naturally conceive the lines as expanding out from the wire, when the current starts, and to continue to expand as long as it is increasing. When it reaches its normal strength, the lines will become stationary, and remain so until the current begins to die out. Then they will begin to contract upon the wire and disappear, the last one vanishing when the current stops entirely.

If passing a current through a wire develops a magnetic field around it, it may naturally be asked:

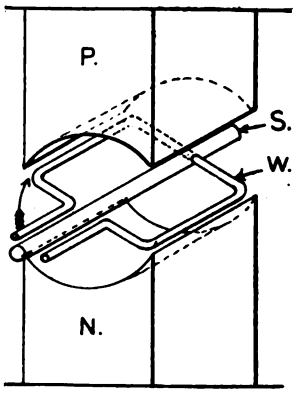

FIG. 11.

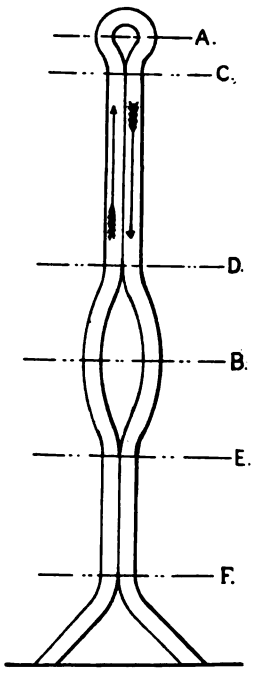

FIG. 10.

What would be the result if we moved a wire in which there is no current, into a magnetic field? Since a wire carrying an electric current is surrounded by a magnetic field we would infer that a wire surrounded by a magnetic field would be traversed by a current, and therefore, that if we move a wire into a magnetic field the effect will be to develop in it an electric current. This influence is perfectly true, providing the position of the wire is such that the lines of force can surround it, and not run parallel with it.

By passing an electric current through a wire a magnetic field is developed, and by moving a wire across a magnetic field an electric current is developed. The movement of the wire across the field may be effected either by an actual movement of the wire, by mechanical means, or by a movement of the lines of force, produced by increasing and decreasing the current in the wire.

Fig. 11 shows, in an elementary way, the manner in which the mechanical movement of the wire across the field is effected in all the various types of electrical machinery. P and N represent the poles of a magnet. From what has already been said it will be understood that the space between them in which

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the shaft S, carrying the wire loop W is located, is traversed by lines of force. The rotation of the shaft, in the direction indicated by the arrow, will cause the loop W to cut through these lines and thus a current will be developed in it. When the loop is at right angles with the poles its sides will move in a direction nearly parallel with the lines of force, as is more clearly shown in Fig. 12, and when it is in line with the poles its sides will cut across the lines of force at right angles. In the first position little or no current will be developed, because the wire moves with the lines and does not cut them. In the second position the greatest current will be developed, because the wire cuts square across the lines of force. The direction of the current developed in the wire by the rotation of the loop will be reversed if the direction of rotation is reversed; that is, if the loop is turned half-way around the circle and then back to its original position, the current during the first movement will be in the opposite direction to that during the second movement. If the movement is continued in the same direction, the part of the loop that passes across the upper half of the field will have a current developed in the same direction in space, say up from the paper; the part passing across the lower half will also have a current developed in it in the same direction in space, which will be down through the paper. As at each half revolution the sides of the loop change their position from top to bottom, it follows that twice in each revolution the direction of the current in the wire will be reversed. As many minds become badly tangled up in endeavoring to trace out this point, it will be explained more fully in the next article, in which will also be shown the devices by which the reverse currents are caused to flow in the same direction in the wire outside the loop.

It has been discovered that the use of fireproof wood on the ships of the Navy causes a corrosive action destructive to surrounding metals. This is said to be owing to the presence of some chemical substance used in the process of fireproofing.

HOME AND FOREIGN EXCHANGES.

Method of Loading Coal at Lake Docks.

The summer meeting of the Ohio Institute of Mining Engineers, June 15-18, took the form of an excursion that carried the Institute over 600 miles by rail and boat, the particular line of inquiry being into the methods of loading coal at various Lake Erie docks. The Ohio Institute had invited the members of the Western Pennsylvania Central Mining Institute to go on this tour of inspection. Leaving Columbus at 11.35 A. M., June 15, the party arrived at the docks of the Short Line Railroad on Sandusky Bay, at 3 P. M. Here they examined the old method of loading vessels with buckets and cranes, the plant being interesting because it was the first to eliminate shoveling. The Thornburgh rapid loader now in course of construction was seen, but owing to its being incomplete the railroad company has not as yet begun to load for its Northwestern trade. At the B. & O. docks, which were next visited, vessels were also being loaded by buckets and cranes. On invitation from an elevator company the visitors next saw the rapid transit method of handling grain, whereby through the use of an endless belt some 7,000 bushels of wheat are moved per hour. The wheat is carried on the flat belt at a rapid rate without spilling, and when the turn of the belt is reached it pours into the funnel without the loss of a single grain.

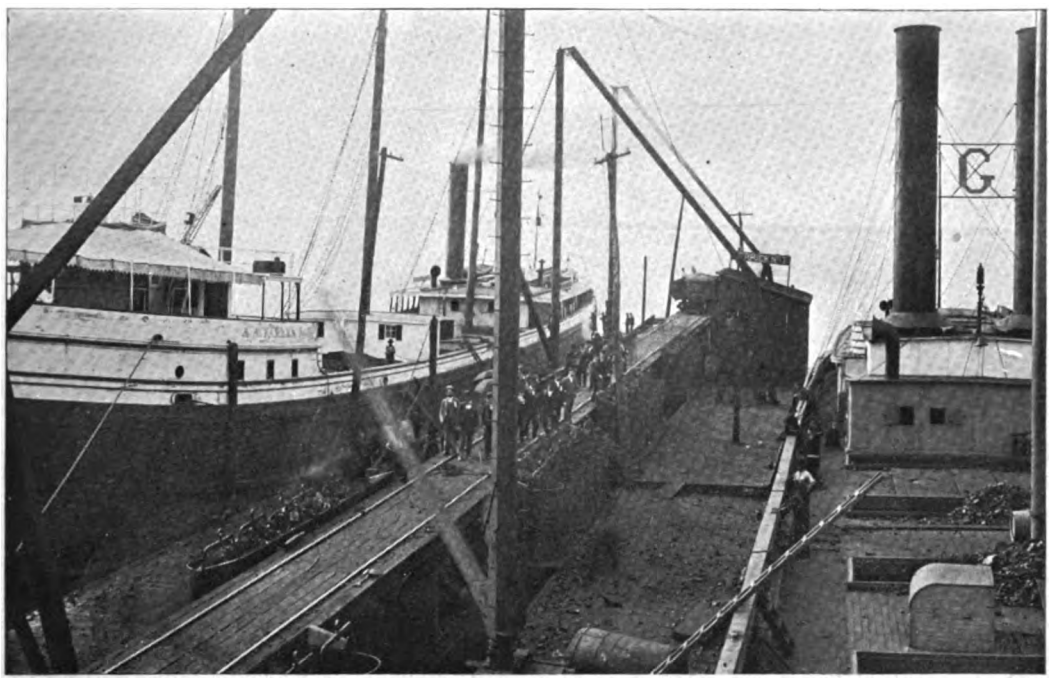

FIG. I—B. & O. DOCKS, SANDUSKY, O. CRANE AND BUCKET SYSTEM, THE FIRST TO DISPENSE WITH SHOVELING.

Wednesday morning the excursionists boarded the Maud Preston for Huron, where the operations of the McMyler unloading machine, there used for handling the mountains of iron ore piled up along the docks, were watched with interest. The speed with which this work is carried on is surprising, as is also the saving of manual labor. The buckets being placed near the bottom of an ore-pile are filled with very little shoveling. At Huron the excursionists also examined the Brown hoist for loading coal, which is

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said to have a guarantee of 3,000 tons. Some of the party timed the machine while it loaded 30 tons in 7 minutes and 18 seconds. But 40 seconds elapsed from the time the railroad car was taken until the coal was dumped into the six buckets ready for loading. These buckets each hold five tons. The apparent ease and rapidity with which these immense masses of heavy material are moved and transferred excited great wonder among those not accustomed to such sights. This machine is very much complicated, from a mechanical standpoint, but saves the coal from breakage as well as or better than any of the other types.

At Lorain the party was taken in charge by S. M. Smythe and others of the Johnson Co., being greeted also by a large delegation from the Engineers' Club of Cleveland. Electric cars took them to the Johnson Co.'s steel works, situated about four miles from the landing. The inspection of the steel works occupied most of the afternoon. It should be noticed that this plant holds the world's record for making steel in shortest time after beginning to build plant. A visit was also made to the site for the docks to be built by the steel company and the proposed site for the furnace plant.

On Thursday morning the Maud Preston was towed about the river at Cleveland to various points of interest. The first visit was to the Cuddy-Mullen plant on the outside of the harbor, situated on the Cleveland and Pittsburg Railroad tracks. The McMyler side dump is used. The party next visited the Brown hoist on the C. & P. R. R. dock, located in the old river bed. This plant is of the same design as the one at Huron. Then they were taken to the Long[1] car unloader built by the Excelsior Iron Works, of Cleveland, and located on the Erie Railway tracks. Passing up the river, the party was shown a machine being erected on the Valley Terminal Railroad of the McMyler pattern, in many ways similar to the Long machine, the chief difference being that under the spout a drop bucket is used which will lower the coal into vessels, thus reducing the breakage, as the spout is kept full, and the coal slides gradually to its destination without a sudden crash and fall.

For the afternoon a trip was made to Ashtabula Harbor, where the party first examined the Brown hoist, which was engaged in loading the steamer Yuma, a 4,000 ton boat. It is said that this machine can unload 118 cars in 12 hours. This is about the latest system of transfer without shoveling, see Fig. 2, as that at the B. & O. docks at Sandusky, shown in Fig. 1, is the earliest. A visit was paid to the lake shore to examine the first car-unloader ever erected at lake ports. It is the McMyler car-dumper, end-dump type, and works on the cantilever principle. It is said to have an unloading capacity of 16 cars an hour. The machine is the first successfully to load vessels in record-breaking time. The one on the C. C. & S. docks, Cleveland, preceded it in date, but has not approached it in speed, nor in continuous working. Fig. 3 is a view of this machine as in use at the docks of M. A. Hanna & Co., Ashtabula, O.

The foregoing description is taken from the Iron Trade Review, Cleveland, to which we are indebted also for the excellent illustrations of the apparatuses.

[1]This apparatus was fully described in our July issue, p. 35.

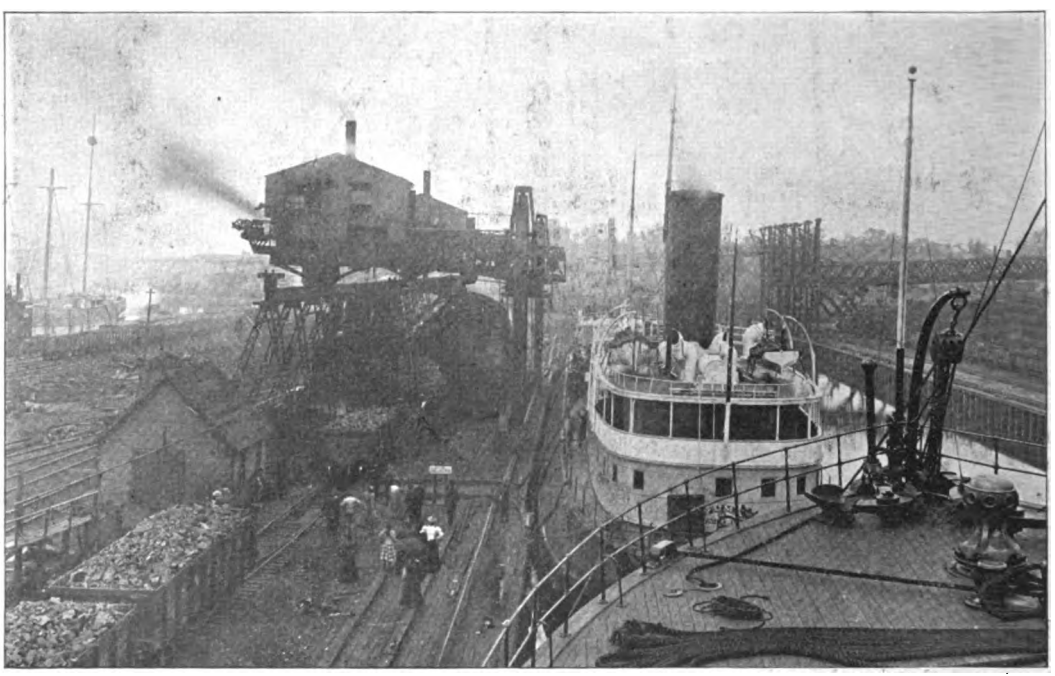

FIG. 2—MINNESOTA DOCK, ASHTABULA HARBOR, O. BROWN SIDE-DUMP UNLOADER, WITH BUCKET TRANSFER SYSTEM.

A Good Deal About Steam.

This very interesting and simple dissertation was written for the American Machinist by Prof. De Volson Wood, shortly before his death. It was accompanied by this memorandum:

"I intended to say much more about steam, but feared I might be too technical and too lengthy, so I let my thoughts run freely about and closed 'early.'

"De V. W."

Heat can be compared with work, and if a pound of water could fall 778 ft. in a vacuum, and all the energy thus acquired could be transformed into heat, it would raise the temperature of the water 1 deg. F. The heat necessary to raise the temperature of 1 lb. of water 1 deg. F. whatever that amount be, is called a British thermal unit with which all other quantities of heat may be compared, and the equivalent value in foot-pounds will be 778 times the number of thermal units.

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The latter, in some simple operations, is frequently immense.

For instance suppose that 1 lb. of water at 51 deg. F., is placed on a stove, or furnace, and subjected to a steady heat, and that in ten minutes the water boils at 212 deg. F. The temperature has been raised 212 — 51 = 161 deg. Suppose, now, that the water continues to boil with constant heat from the furnace and that in 60 minutes 1 lb. has boiled away, passing off as steam. It will be observed that the boiling water has continually the temperature of 212 deg. According to our supposition it required six times as much heat to vaporize the pound as it did to raise its temperature 161 deg. or six times 161 thermal units, or 966 thermal units. The experiment of Regnault, whose methods were perfect compared with the crude method here indicated, gave 966 thermal units to the nearest whole number required to vaporize 1 lb. of water under the pressure of one atmosphere. This is equivalent to 966 × 778 = 751,548 foot-pounds.

and this must be added to 966, giving 1,118 thermal units, giving nearly 870,000 foot-pounds; and if this heat were imparted in 26½ minutes, or 2.26 lbs. so heated every hour, it would equal the energy of 1 horse power. We need not say that 2.26 lbs. of steam, however high the temperature, do not, in practice, produce a horse power; indeed, it is only very recently that a horse power has been produced with so small a weight of steam as 10 lbs. per horse power per hour, and very many engines require from 25 to 40 lbs. One reason for this is, an engine utilizes only a fraction of the heat imparted to it; the very best utilizing scarcely one-fifth of the heat, many good common engines one-tenth, and many one-twentieth, or even less.

Every change of state of aggregation involves a large expenditure of energy. If 1 lb. of ice be melted in 10 lbs. of water at 60 deg. F. it will reduce the temperature of the water about 14½ deg., and if this value were correct it would follow that it requires 14½ × 10 = 145 thermal units

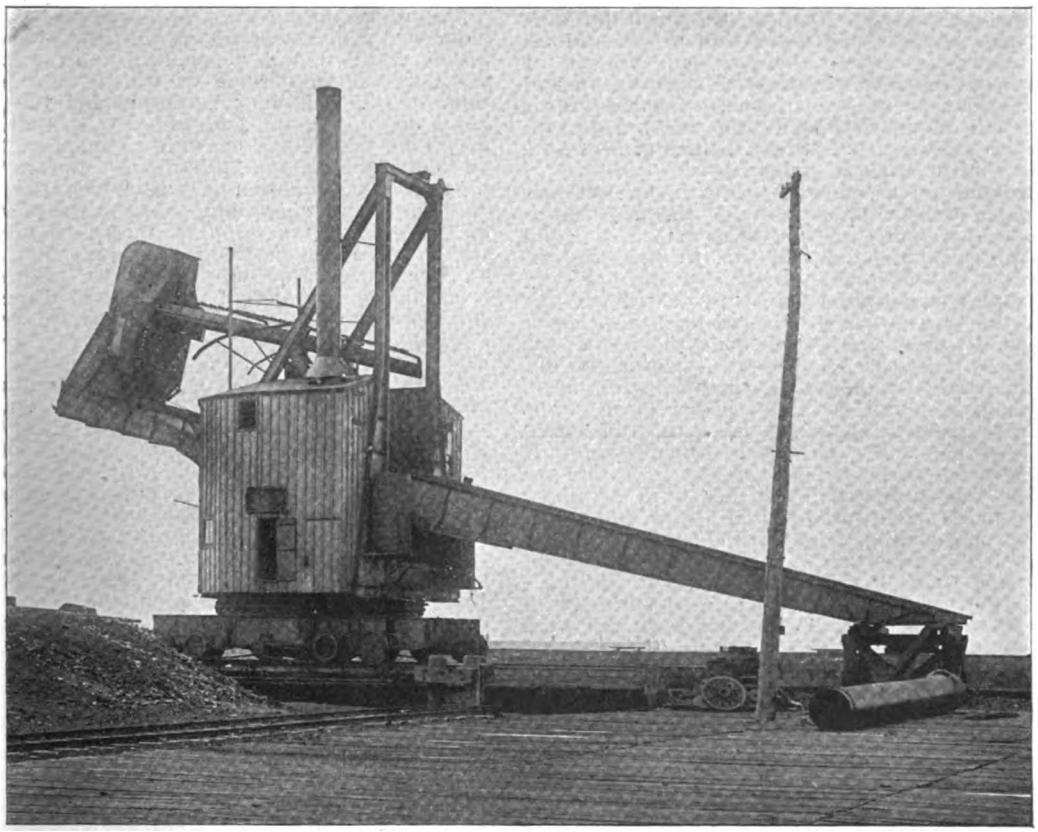

FIG. 3—M. A. HANNA CO'S DOCKS, ASHTABULA HARBOR, O. M'MYLER CAR DUMPER, END-DUMP TYPE.

One appreciates the magnitude of this quantity better by making some comparisons. It is sufficient to raise 1 ton 375 ft. or 100 tons 3.75 ft. The energy of ordinary gunpowder is generally assumed to be 250,000 foot-pounds per pound of powder; according to which, it requires more than three times the energy to vaporize 1 lb. of water under atmospheric pressure than is developed by the explosion of 1 lb. of ordinary gunpowder. The former is done quietly in the course of a few minutes, while the latter is done in a small fraction of a second. This, however, is not all the heat in a pound of water above ordinary temperatures. If the water originally was at 60 degrees F., there were 212 — 60 = 152 thermal units imparted to the water before it boils; to melt a pound of ice. Careful experiments show that it requires 144 British thermal units to melt a pound of ice, and this is equivalent to 144 × 778 = 112,000 foot-pounds of energy. Hence, the energy required to melt or freeze 1 lb., of ice is little less than half the energy in a pound of common powder. When it melts, energy is absorbed by the ice, and when it freezes, energy goes out of the ice into surrounding objects. The energy of melting the pound is equivalent to raising 56 tons weight 1 ft. or of 3.4 horse power to melt a pound per minute. In view of this, it is not surprising that the effects resulting from freezing and thawing water in the earth and in crevices of rocks produces such marked effects as is frequently observed.

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The total amount of heat in any given body is unknown. If a gas were perfect, the amount could be computed; but no known gas is perfect. All the so-called perfect gases have been liquefied. Air is a convenient type of a gas. If air be expanded without supplying it with heat, its temperature will fall; and if it were a perfect gas and the expansion infinite, all the energy in it would be changed into work, and the final temperature would be absolute zero, or 461 deg. F. below the zero of Fahrenheit's thermometer. In this way we have computed the total energy in a pound of air at 32 deg. F. the temperature of melting ice, supposing it to be a perfect gas, and found it to be about 64,000 foot-pounds, or about one-fourth the energy in a pound of common powder. A pound of air at that temperature and under ordinary pressure, occupies nearly 12 1-2 cu. ft. hence 4 lb. would occupy about 50 cu. ft. Hence, the air in a room 2 × 3 × 8 1-3 ft. under ordinary conditions, will contain about as much energy as there is in a pound of common powder. If the speed of a cannon ball be 2,000 ft. per second, the kinetic energy of a pound of it will be about 62,000 foot-pounds, or a little less than the total energy in a pound of air under ordinary conditions.

One does not realize the enormous amount of energy stored in bodies about us, as in air, vapors and solids, so long as it is restrained. One may carry powder with impunity if kept from fire, but a spark may make it destructive. Steam boilers are splendid servants, but destructive masters.

The volume of a pound of steam under different pressures is found with considerable difficulty; but at atmospheric pressure, a pound of dry steam is found to occupy just about 26 1-2 cu. ft. the temperature being 212 deg. F. And a pound of dry air at that temperature will occupy just about 16.6 cu. ft., the pressure being the same; hence, under such conditions, air is heavier than the steam, the steam being about five-eighths as dense as the air.

Plans have been made, and are now being executed, for utilizing some 100,000 horse power of the Falls of Niagara, much of which is to be transmitted to distant points by electrical transmission. It is a grand engineering scheme; but it is put into the shade by the engineering feat displayed in recent Atlantic liners. The former is on and in solid rock, the latter on a floating ship; and the latter carries engines of 30,000 horse-power, together with furnaces, boilers, and fuel. If the work of 8 men equaled 1 horse power, and if there were three shifts in 24 hours, it would require 720,000 men to do the work of the engines on one of these gigantic steamers; and if one steamer could carry the 240,000 necessary for each shift, it would require three vessels to carry the men to do the work on one. This is an illustration of the fact that steam power may accomplish what hand power cannot.

Capt. Ericsson made hot air engines to drive his steamer the Ericsson, which were very economical of fuel; but the four engines, with cylinders 14 ft. dia., developed only 300 horse power, and to develop 30,000 horse power would require 400 such engines, and would make two rows, each more than 2,800 ft. long, or more than half a mile long; while the triple expansion engines of the Majestic, the boilers, furnaces, and fuel are practically hidden in the hold of the ship. Steam is king!

Immense New Floating Dock at Hamburg.

The shipbuilding yard and machine shops of Messrs. Blohm & Voss, at Hamburg, which for years have had in operation a large floating dock known as the Elbdock, have just completed a new dry dock, which is the largest of its kind in existence. So writes W. Henry Robertson, Consul at Hamburg, in the United States Government Consular reports for the month of July.

This new floating dock has a carrying capacity of 17,500 tons. Its length, with pontoons, is 624 ft. 4 in., and its width 118 ft. 1 in. It is able to raise the largest merchant vessels that have thus far been built, and even the heaviest men-of-war, and consists of seven separate pontoons with high and strong side pieces. These seven pontoons can be joined together, so as to form one connected system. Each side piece contains an engine and boiler room for the pumps and electric and hydraulic machines. These two machines have condensers and 700 indicated horse power each. They drive 14 pumps, which are capable of pumping out the dock in 45 minutes, and thus of raising the largest vessel in this short space of time. In order to regulate the raising and the lowering of the dock, it was necessary to divide each pontoon into several water tight compartments, which are closed by means of stop valves. All these stop valves can be moved from one point by means of hydraulic power, and the depth of water in all compartments is indicated by special apparatus. By this arrangement it is possible for one person to manage all the stop valves and to direct the pumping.

The blocks upon which the vessel rests are easily movable by machinery from the side pieces. Altogether, this new dock is supplied with the most modern improvements, some of which were especially constructed. The dock harbor behind the shipyard has a depth of 26 ft. 2 in. below 0, so that, at ordinary high tide vessels drawing as much as 26 ft. can be docked. A bridge 118 ft. long connects the dock pontoon with the shore, from which the dock is, therefore, quite accessible. Next to the pontoon and on the quay of the shipyard, there is a huge crane, which, when projected 65 ft., can raise 150 tons, and 45 tons when projected 106 ft. By means of this crane heavy loads can be transferred directly from the shore into the dock across the largest vessels.

Owing to its peculiar construction this great dock can, in cases of emergency or in time of war, be transferred to Brunsbüttel, at the opening of the Kaiser Wilhelm Canal, to dock vessels which have sustained heavy damages or whose draft is great. As a matter of fact, it is capable of docking vessels with a draft of 29 ft. 6 1-2 in. No vessel with a greater draft than 27 1-2 ft. has thus far succeeded in coming up to the port of Hamburg.

Upon applying to the owners of the dock I was informed that no fixed schedule or charges for the use of the same had been or would likely be determined. It was believed to be more profitable to make special arrangements in each case. I was given to understand that not even the German Government had been furnished with any tariff of docking charges, and that for the docking of foreign vessels of war it was probable that there would be charged about $975 for the first day and $250 to $500 for each following day. Messrs. Blohm & Voss desire it to be expressly understood, however, that they do not bind themselves to these figures.

LARGE HOME AND FOREIGN DOCKS.

Docks.	Length Feet.	Docks.	Length Feet.
Belfast	825	Havre	535
Birkenhead:		Marseilles	593
No. 1	750	Genoa	720
No. 2	930	Baltimore (Simpson's)	504
Cardiff	600	Brooklyn:	
Liverpool	768	Erie No. 1	620
London (Tilbury)	875	Erie No. 2	510
Newcastle (Wallsend.)	520	Newport News:	
Southampton	750	At top	600
Antwerp	429	At bottom	560
Cherbourg	508	Norfolk, Va.	500

There is little doubt that this capable and energetic firm, by the construction of the new dock, have met a long-felt want in Hamburg, whose docking facilities have of late years by no means kept pace with its shipbuilding. The Hamburg-American Line, especially, will have reason to look with favor upon the new enterprise, as it will enable them to dock their

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express steamers and large freight boats in their home port, instead of having to send them to English or American docks. The North German Lloyd, of Brémen, which also has some very large boats, and is building more, will (as well as the German imperial navy) doubtless be glad to avail itself of these excellent facilities.

Although it is easy for persons connected with shipping to look them up in Lloyd's Register, I deem it not uninteresting to give, by way of comparison, the lengths of the largest graving docks in the world:

It will be noticed that a large proportion of these graving docks are longer than Messrs. Blohm & Voss's new floating dock, which latter, however, far exceeds the dimensions of other floating docks in existence, the length of which is seldom more than 300 to 400 ft. It seems the builders desired a dock which could be transported to almost any part of the river below this port, and also one which they considered superior to any graving dock for the safe handling of large and long vessels.

NEW PUBLICATIONS.

ANNUAL REPORT OF THE OPERATIONS OF THE UNITED STATES LIFE-SAVING SERVICE, for fiscal year ending June 30, 1896. Washington, Government Printing Office, 1897, pp. 533.

Departmental reports are not usually the most interesting books for other than the reader who seeks figures on some particular subject. This report, however, is an exception, containing as it does a year's record of hazardous work bravely done by the efficient members of this most important branch of the civil service. The services of crews for the fiscal year set out in diary form fill many pages, and contain many an interesting story of adventure and heroic work. Besides the saving of lives, however, there is the brief record of the prevention of destruction of hundreds of thousands of dollars' worth of property by prompt work of the various crews, in warning vessels of approaching dangers and in rescuing vessels from perilous positions. There are 256 stations on the lake and sea coasts, and the work performed during the year is thus reported by General Superintendent Sumner I. Kimball: "The number of disasters to documented vessels within the field of station observations during the year was 437, and there were on board these vessels 4,608 persons, of whom 13 were lost. The estimated value of the vessels was $8,880,140, and that of their cargoes $3,846,380, making a total value of property involved $12,726,520. Of this amount $11,293,770 was saved to the owners and $1,432,750 lost. The number of vessels totally lost was 67." These figures do not take any account of the numerous cases of aid rendered to small pleasure craft. There is a very interesting entry under the head of "Vessels warned by night signals," dated January 25, 1896. This was the memorable night when the St. Paul went ashore at Long Branch, and an unknown steamer followed her example. The entry regarding the unnamed vessel reads in part, "She appeared to be a large trans-Atlantic vessel, almost broadside to the shore, and looked to be stranded, but while preparations were being made to get the beach apparatus ready for use she backed out of her perilous position." The name of this mysterious vessel seems to be as unobtainable as that of Billy Patterson's assailant. Other matters contained in the report are a fine collection of letters acknowledging the services of crews; awards of medals since 1876, with brief narrative of rescues; table of casualities, giving very complete details; statement of appropriations and expenditures; instructions to mariners in case of shipwreck; list of districts and exhaustive tables of wrecks and casualties at home and abroad. There is also a report of the board on life-saving appliances.

INVESTIGATION INTO THE ACTION OF A SCREW PROPELLER, with special reference to the comparison of actual trial data with formula representing model experimental results. Printed for private circulation. By Bernhard A. Sinn, M. E., New York, pp. 59. With many drawings.

This work is an extensive investigation into the theory and modern practice of screw propulsion. Its main purpose was to compare about 250 actual trials with a formula derived from Froude's experiments and modified by Prof. W. F. Durand, of Cornell University, to allow of differences in area and shape. The investigations show some very great peculiarities in propeller design, and also show that the formula modified as above agrees in 60 per cent of the cases with the actual trials. The work is very completely illustrated with charts and drawings of screw propellers. The tables and information contained therein are based on 250 trial trips, and the tables contain complete dimensions of vessels and propellers, and finally a complete analysis of the performance of each propeller. The vessels are representative, ranging in size from a 58 ft. tug to a 512 ft. ocean liner, and propellers from 4 ft. to 28 ft. dia.; single, twin, and triple screw vessels from 8 to 24 knot speed. Over 70 different shaped propellers are shown, and the results show an efficiency for the scientifically designed greatly in excess of what might be termed the hit or miss design of propeller. Of all the vessels treated the United States cruiser Marblehead shows the maximum efficiency of propeller.

BLUE BOOK OF AMERICAN SHIPPING. Marine Review, 409 Perry-Payne Building, Cleveland, O., pp. 447. With illustrations. Price $5.00.

This book is fitly termed by the publishers a Marine Business Directory of the United States, as it covers both the sea coast and lake interests. It contains the lists of vessels usual in such works, and besides lists of owners' and officers' names and addresses, statistics of lake commerce, and many pages of information regarding deep sea interests. The illustrations are numerous and interesting.

The twenty-second annual review of the Daily Commercial News, of San Francisco, issued during July, is one of the best all-round publications of the sort we have ever seen. Not only is it an exceptionally fine specimen of good printing, but its arrangement and diversity of interesting contents show good judgment and care. The statistics are carefully worked up into tables of convenient reference, covering all the exports of grain, lumber, and salmon from the coast. There is a very complete chapter of marine mishaps, and a great variety of articles of interest to the merchant and shipping classes of the coast. The illustrations are numerous and good. Copies of the Review can be had by forwarding 25 cents to the Commercial Publishing Company, 34 California street, San Francisco, Cal.

CATALOGUES.

The series of bulletins which is being published by the Bullock Electric Manufacturing Company, St. Paul Building, New York, and Cincinnati, Ohio, contain a great deal of matter of much value to every man who has to do with the generating or utilizing of electricity. Some of the text may refer more particularly to the operation of machine tools, or other machinery by the use of electric motors direct-connected, but the principle is the same that it would be in a

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hoist ventilator or other apparatus which might be used in any branch of engineering in the marine field. The Bullock motors are made of different speeds, and can be adapted to all uses, from operating machinery in a shipyard to doing various kinds of work on the dock or on board ship. The bulletins are published from time to time as occasion demands, and readers of Marine Engineering who are interested in studying up the practical uses of electricity should send to one or the other offices of this company for copies.

One of the handsomest catalogues of the season is just received from the Deane Steam Pump Company, Holyoke, Mass. It comprises 132 handsomely printed and profusely illustrated pages, devoted to pumping machinery. Each type of pump is shown in a half-tone engraving, and in many instances sectional views are also given. The cover of the catalogue is flexible black board, and the printing upon it in gold. Under the heading of machine pumps will be found full detailed description of light service pumps, surface condenser with vacuum and circulating pumps, combined single vacuum and water pumps, independent condensing apparatus, boiler feed pumps, vertical and horizontal piston pumps for general service, ballast pumps, etc. In addition there is a great deal of general information of much value to engineers regarding pumping apparatus. Copies of the catalogue can be had upon application to the company by mentioning Marine Engineering.

An artistic little book is that entitled "Testimonial Wonders; Songs of Praise about Patent Elastic Felt Mattress," received from Astermoor & Co., 116 Elizabeth street, New York. It is printed on coated paper, in black, and has marginal notes, headings, etc., in red. Several testimonials testify to the extensive and very successful use of these mattresses in the navy and in Government vessels, as well as in the merchant marine. This booklet is devoted entirely to testimonials, but another, entitled "The Test of Time," illustrates and gives in detail the manner of making the mattresses and the various uses to which they are adapted. Copies of either booklet can be had upon application.

Duval metallic packing is fully illustrated and described in a catalogue just received, and many pages of testimonials are added, showing the value of this packing for all uses, especially in marine work, for piston rod, stuffing boxes, valve rod boxes, air pump buckets, feed pumps, bilge pumps, etc. The cover is very neatly printed in three colors, and the body of the catalogue is correspondingly well printed. B. J. Carroll, 43 John st., New York, is agent for this packing.

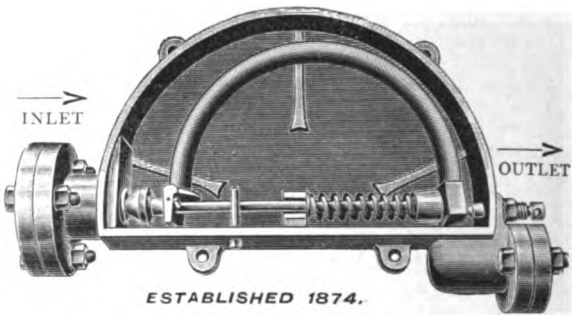
The gas engine catalogue issued by the Westinghouse Machine Company, Pittsburg, Pa., like all the publications of this company, is a beautiful specimen of the printers' art. The illustrations are full size of the page, 7 by 9 in., of very light quality, and the press work is in keeping. Very few catalogues have such concise detailed descriptive matter as this. In short, it is a model catalogue.

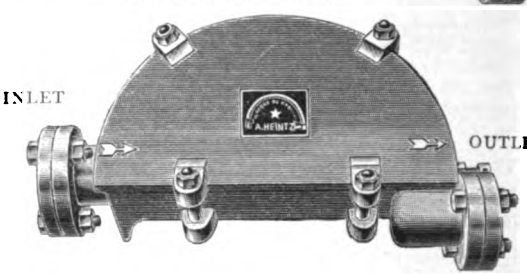
J. M. Hayden & Co., Grand Rapids, Mich., have just issued a little book of testimonials regarding their Globe box metal. The book is circular, about three inches in diameter, the cover being of red paper, printed upon with silver bronze, reproducing the color of the metal. Users of box metal will find it well worth looking over this book.

The catalogue at hand from the Power & Launch Company, Bridgeport, Ct., illustrates a variety of boats, from small yawls and dinghys to large naphtha and steam yachts. The illustrations are large and comprehensive, and the descriptive matter as complete as could be desired. Every person interested in such craft should send for one of these catalogues.

Engineers interested in posting themselves on the various kinds and types of lubricators, oil cups, safety valves, and injectors, should send to the Swift Lubricator Company, Elmira, N. Y., for its new catalogue. It is well illustrated and describes in some detail the various specialties referred to.

A Marine Trap That Never Fails.





The Heintz Steam Saver

*****—

has been adopted by the Marines of Belgium, France, Russia and Germany and is now attracting universal attention amongst the fraternity in the United States, where it is now being introduced.

WHY

it does so can be readily understood by noting the reasons. It is the SIMPLEST trap in existence. Has no levers, floats, air valves or grinding joints to wear out. Works in ANY POSITION at any pressure up to 200 pounds. "Pitch" or "list" on the ship has no influence on its results.

ELEVATES the water anywhere.

CONSUMES NO STEAM.

DOES NOT BACK UP.

NO INSIDE PRESSURE.

Easily and quickly opened.

LASTS A LIFE-TIME.

Chief Engineer the International Steamship Co., says:—
"I like the trap better than any I have ever used."
"A. F. BREMNER."

THE CHEAPEST as well as THE BEST.

A postal card is enough to learn all about it.

WILLIAM S. HAINES,

Sole Manufacturer for U. S. and Canada,

136 F. South Fourth St., - Philadelphia.

AGENTS,

Western Steam Appliance Agency, Congress and Franklin St., Chicago, Ill.

Chas. F. Chase, 26 Milk Street, Boston, Mass.

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FOR MARINE ENGINEERS.

A Chief Engineer has something to say concerning Dixon's Pure Flake-Graphite that is worth the reading.

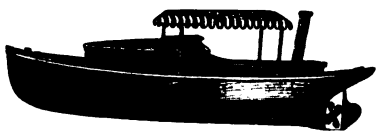
I can highly recommend Dixon's Pure Flake-Graphite as a lubricant for external parts, such as hot pins, journals, etc. We had the High Pressure and Low Pressure connecting-rod brasses run hot in leaving Galveston. These brasses had been adjusted when in port by applying the Flake-Graphite mixed with oil. It entirely cooled them without causing us to stop and ease nuts back. It is an exceedingly good lubricant for slide valves and pistons. We had some heavy weather between Galveston and Norfolk, with engine racing heavy at times. The boilers are inclined to prime a little with racing, causing the H. P. slide valve and gear to work very heavily, and by giving the slide valve a little Flake-Graphite mixed with water it entirely does away with all the bad jarring and rough working of the gear, and I find that one-half of an ounce of Flake-Graphite is equal to one pint of good cylinder oil for causing valve and gear to run smoothly.

I can with the utmost confidence recommend it for either internal or external parts for lubrication.

JAMES STEPHENSON,
Chief Engineer, S. S. Llanthony Abbey.

Any Engineer who is not familiar with this wonderful material will receive sample and pamphlet free of charge.

JOSEPH DIXON,
Crucible Co., Jersey City, N. J.



ALCO VAPOR

Hunting Launch.

Sportsman's Floating Camp. Motor controlled from bow. Valve movement, 12 to 1. 16 to 60 ft. Launches. Twin Screws a specialty. 1, 2, 3, 5, 7, 12, 14, and 20 h. p. No licensed engineer or pilot required. Speed and Safety guaranteed. **No dangerous Naphtha or Gasoline used.** No disagreeable vibration. SEND TEN CENTS IN STAMPS FOR 1897 CATALOGUE.

MARINE VAPOR ENGINE CO., Foot Jersey Ave., Jersey City, N. J.

SINTZ GAS ENGINE COMPANY,

GRAND RAPIDS, MICHIGAN, U. S. A.,

Manufacturers of

Marine and Stationary Gas and Gasoline

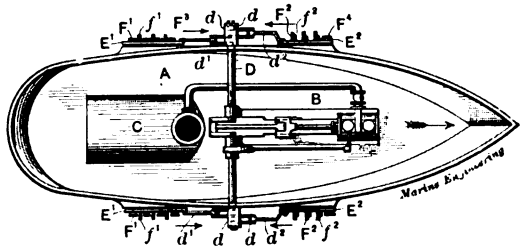
ENGINES.

Also Yachts and Launches.

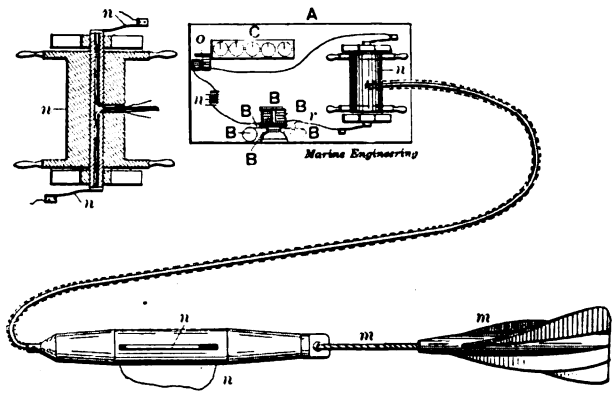
SELECTED PATENTS.

586,390—MEANS FOR PROPELLING SHIPS. *Jean B. Pinchard, San Francisco, Cal. Filed July 22, 1896.*

In an apparatus for propelling vessels, suitable guides secured to the side of the vessel, reciprocating frames moving in guides, and a mechanism for reciprocating the frames, combined with two sets of wings, one for propelling and the other for backing the vessel, hinged to the frames; hooks for locking each



set of wings in a closed position, a slide for each frame, and to which the two sets of hooks are secured, and means for adjusting each slide so that either set of hooks can be brought into use. In an apparatus for propelling vessels, suitable guides, a sliding frame, and two sets of wings, which operate in opposite directions, combined with an endwise-moving slide carrying hooks for each set of wings, an operating mechanism for moving the slides, located inside of the vessel, and connecting with the slides through the sides of the vessel, a sliding frame provided with stops f^1 f^2 f^3 f^4, two sets of hinged wings F^1 F^2 F^3 F^4, which operate in opposite directions; and two sets of hooks turned in opposite directions, for locking either sets of wings, combined with slides to which the hooks are secured; the pins projecting from the inner sides of the slides, the sliding bolts having outwardly-turned ends, and the levers H, and pins h^1 h^2, for reciprocating the bolts, the combination of a sliding frame having two sets of oppositely-hinged wings, a locking-bar provided with oppositely-pointed hooks arranged to slide respectively and alternately over one set of the wings and lock the same, a lever,



and suitable connections, whereby the lever is made to shift the bar and the hooks.

584,095—SPEED INDICATOR FOR SHIPS. *Warren H. McCurdy, Boston, Mass. Filed Feb. 10, 1896.*

A ship's log, having a chamber for the reception of an insulating plug, and open at its end for the reception of an electric cable, combined with the cable

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provided with strength-giving wires and electric wires wrapped together within an insulating protector, and having its strength-giving wires fixed to the log, and the electric wires inside the log being separated from these wires, and arranged to coöperate with a push button. The combination with an electric cable, of a ship's log composed of a hollow divided shell, containing an independent frame having opposite heads packed water tight and inserted in the shell, and containing a cam and means to move it to actuate a push button to effect the closing of an electric circuit. In a ship's log, a head having a projection, and a slide rod having a collar, combined with a piece of tubing surrounding the rod, and connected to the head and collar to form a water-tight joint. A ship's log composed of a hollow divided shell having at one end a rotating driving shaft, and having within the shell a train of mechanism, and a shaft extended outwardly from one of the heads to be engaged and driven by the driving shaft, combined with a stuffing box, through which the shaft driven by the driving shaft is extended. A ship's log, and a rotator, a driving shaft mounted in the former and connected to and to be rotated by the latter, and a driven shaft within the log, the two shafts being connected together end to end by disks and pins. In combination with a ship's log, an electric cable containing electric wires, and strength-giving wires, nested together in a compact bunch and bound together by a protecting covering, the latter wires being secured to the log.

BUSINESS NOTES.

THE NEW YORK MARITIME REGISTER has in preparation an International Domestic and Export Edition, which promises to be a very valuable medium through which to reach commercial houses in all parts of the world.

A POLICE BOAT.—The Marine Vapor Engine Co., Jersey City, N. J., has been awarded contract for a police boat for the City of Brooklyn, in competition with leading launch builders. It will be equipped with the well known alco vapor engine.

GREENFIELD ENGINES.—With a reputation of years' standing for their simple engine, W. G. & G. Greenfield, East Newark, N. J., are finding considerable enquiry for their new compound. Many of their simple engines are in use for operating electric plants on well-known yachts.

A COMPOUND ENGINE.—John E. Thropp & Sons, Trenton, N. J., are distributing folders descriptive of their well known comp und engine for yachts, tow boats, etc. It is a fore and aft engine, very solid of construction, designed for pressures up to 300 pounds. Copies of the folder are sent to all asking for them.

THE VIADUCT REDUCING VALVE.—The success attained on the lakes by the balanced piston pressure reducing valve made by the Viaduct Brass Works, Cleveland, Ohio, has been of much value in introducing them on the Atlantic coast. The Eastern agent is Mr. C. H. Tucker, 135 Greenwich Street, New York.

BIG BARROW MAKING.—The volume of business done by the Lansing Wheelbarrow Co., Lansing, Mich., which devotes itself exclusively to barrow making, will surprise many people when they learn that it exceeds seventy-five thousand barrows a year. One of the types of dock barrows is illustrated elsewhere in these columns.

MARINE STEAM TRAPS.—One of the most extensively used steam traps in the world is the "Heintz," which has a great reputation abroad, and which is now being introduced in this country by William S. Haines, 136 South Fourth street, Philadelphia. The latest circular states that over 50,000 of these traps were in use up to last March. Copies of this circular and full detail regarding the trap can be had upon application.

GRAPHITE LUBRICATION.—The following is an extract from a letter which has been received by the Jos. Dixon Crucible Co., Jersey City, N. J. "I have used Dixon's Pure Flake-Graphite on all the main rubbing surfaces, H. P. Valve included, and have much pleasure in recommending it to any one who wishes t improve valve or cylinder faces, combined with a saving of oil." D. Ranken, Chief Engineer S.S. Britannia, Galveston, Texas.

SAMPLES OF PACKING GIVEN AWAY.—If the representations made by Jas. L. Robertson & Sons in their advertisement can be carried out by them, it ought to pay every engineer operating high pressure engines to send for a sample of their indestructible packing. There is a great demand for such a packing, and the manufacturers claim that they have been testing it for nearly three years, and have some strong testimonials.

PACKING FOR HIGH PRESSURES.—The asbesto-metallic packing now being manufactured by The American Steam Packing Co., 60 Federal street, Boston, Mass., is reported as

The Mason Reducing Valve.

Especially Adapted for Marine Work in connection with Heating, Lighting and Steam Steering.

ADOPTED BY

THE U. S. NAVY, and used entirely on all Warships including the new Torpedo Boats "Dupont" and "Porter."

THE NORTHERN S. S. CO., and used entirely on their Steamers "Northwest" and "Northland."

THE PENNSYLVANIA R. R. CO., and used entirely on their new Ferry Boats "St. Louis" and "Pittsburgh."

AN EXCERPT FROM ABROAD:

ELSINORE, DENMARK, Nov. 17, 1892.
MR. A. B. RECK, Copenhagen, Agent,
THE MASON REGULATOR CO.,
Boston, Mass.:

We beg to say that we have formerly, in the steamers with triple expansion engines, tried different constructions of reducing valves for the high steam pressure of 160 lbs. to the lower of 5 to 100 lbs., with frequent complaints over the unreliableness of these; but after having now for several years used the Mason Reducing Valves, we have not only been exempt from complaints, but have, on the contrary, heard these valves much praised; and can therefore recommend the Mason Reducing Valve as being, in our opinion, of the best construction that exists, reliable in all respects and quick in its regulation.

Yours respectfully,
THE DOCK YARD AND ENGINE FACTORY OF ELSINORE.

THE MASON REDUCING VALVE IS A PERFECT WORKING APPARATUS, AND IS THE RESULT OF 15 YEARS' EXPERIENCE IN THIS LINE. WE GUARANTEE THEM AND WILL SHIP ON TRIAL.

Catalog Sent On Application.

THE MASON REGULATOR CO.,

BOSTON, MASS., U. S. A.

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